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KEY TO GEOGRAPHY,

OR,

A COMPLETE GUIDE
TO THE
USE OF THE *GLOBES.*

TO WHICH ARE PREFIXED,
AN EASY INTRODUCTION
TO
DECIMAL ARITHMETIC,
AND THE
EXTRACTION OF ROOTS.

LIKEWISE,
AN APPENDIX,
Being a curſory View of the SOLAR SYSTEM, introduced in a Dialogue between the *Maſter* and *Scholar,*
IS ADDED THERETO.

By JOHN RICHARDSON,
SCHOOLMASTER, SHEFFIELD.

Illuſtrated with an ELEGANT FRONTISPIECE,
ENGRAVED FOR THE PURPOSE.

"I ſaw, and conſidered it well; I looked upon it, and received Inſtruction." *Proverbs.*

SHEFFIELD:
Printed for the Author by GALES and MARTIN, and
ſold by G. G. J. & J. ROBINSON, *London,* and S.
HODGSON, *Newcaſtle.* 1787.

BRITISH MUSEUM

TO THE

SCHOOLMASTERS

AND

HEADS OF ACADEMIES

OF

GREAT BRITAIN & IRELAND,

WITH THE

COLONIES THEREUNTO BELONGING;

THIS

SMALL TREATISE

ON THE

GLOBES

IS MOST HUMBLY INSCRIBED,

BY THEIR MOST OBEDIENT SERVANT,

AND FELLOW-LABOURER,

J. RICHARDSON.

6

ERRATA.

Page.	*Line.*	*for*	*read.*
26	12	12231	12321.
34	6	639	739.
80	6	Zores	Azores.
96	2	IX.	VIII.
—	23	14th	24th.
111	25	40	42.
140	10	Zone	Zones.

BRITISH MUSEUM

PREFACE.

AS Geography is now cultivated by all Ranks of People, and as a Knowledge of it is indiſpenſibly neceſſary, towards what is termed *a genteel Education*; it is preſumed, that *every little* towards its Improvement will be acceptable.

That the Study of Geography is exceeding pleaſant, eſpecially when accompanied by the Uſe of the Globes, will be allowed by *every one*; without which, indeed, it would be next to an Impoſſibility, to make any tolerable Figure in the Science.

It is ſaid, that *Alexander the Great* applied himſelf cloſely to the Study of Geography, particularly of the Kingdoms which he conquered, or wiſhed to conquer; and that it was chiefly owing to his Skill in that Line, that he gained a Victory over *Darius* (whoſe Army was much ſuperior) at the Battle of Iſſus. Craſſus, who was not ſo well ſkilled as Alexander, in Geography, was ruined by truſting to the Guidance of the Traitor *Andronicus*.

Geography is not only uſeful to Generals, or any particular Set of Men, but to ALL; and it was truly ſaid, by an eminent Author, that, "There is not a Son or Daughter of Adam, but has ſome Concern in Geography."

By a Knowledge of *Geography* and the *Uſe of the Globes*, we are imperceptibly led into a Train of lively *Ideas*, on the Works of *Creation*, and greatly aſſiſted by it, when contemplating the Beauty and Harmony of the material Worlds.

The following Sheets, which I had drawn together, for the Uſe of my own School, (after adviſing with ſeveral *eminent Teachers* on the Subject) and which, by the Advice of a few Friends, I now offer to the PUBLIC, will, I hope, prove worthy of the Title they bear; *i. e.* "A Key to Geography; or, A Complete Guide to the Uſe of the Globes." And, though I might have extended the Work to a large octavo Volume, as many of my Predeceſſors have done, with, perhaps, leſs Matter, I rather choſe to confine it to the portable Size, in which it now appears, and to a Price within the reach of every One.

After the Introduction to Decimal Fractions (which I have given in as plain and eaſy a Manner as poſſible) with the Extraction of Roots, I have preſented the *Learner* with the neceſſary Definitions, geographical and aſtronomical.

In the next Place, is a compendious Syſtem of the Geography of the terraqueous or terreſtrial Globe, with uſeful Tables, of the *Four Quarters* &c. and ſuch as are not common in Works of this kind.

In Part 3d I have given Fifty-two Problems on the terreſtrial Globe, with their Solutions, together with a variety of explanatory Notes.

The fourth Part contains ſix Problems by the Analemma, with their Solutions; for which I am, in ſome Degree, indebted to the late ingenious Mr. THOMAS DILWORTH, a Gentleman who laboured hard for the *Public Good*, and whoſe Works have gained him a living Name,

The fifth Part includes Twenty-five Theorems, or undeniable Truths, deduced from the Problems given upon the terreſtrial Globe.

In the ſixth Part are Twenty-four Aſtronomical Problems, on the celeſtial Globe, with their Anſwers; likewiſe, a Table of the Magnitudes, Right Aſcenſions, and Declinations, North or South, of thirty principal fixed Stars; and, laſt of all, an Appendix, being a curſory View of the Solar Syſtem, introduced in a Dialogue between the Maſter and Scholar, intended as a means of drawing the young Tyro towards the Confines of Aſtronomy.

That the whole is intended for the Uſe of Schools, as well as private Perſons, will appear on the Peruſal; and the candid and judicious Reader will pardon the few Errors that may have crept into the Preſs, and eſcaped my Obſervation, it being almoſt impoſſible for *firſt Editions* in a Work of this kind to come off *entirely free*. The moſt obvious, I have, however, collected, and the Reader will pleaſe to remark them before he enters upon the Work.

Any Hints where Amendment is neceſſary, will be gratefully acknowledged.

The Nobility, Gentry, and Others, who have favoured me with their Names, as an Encouragement to the Undertaking, will be pleaſed to accept of the humble and hearty thanks of *one*, who is happy in ſubſcribing himſelf,

Their moſt obedient,

And much obliged Servant,

THE AUTHOR.

SHEFFIELD, April
28th. 1787.

AN

INTRODUCTION

TO

Decimal ARITHMETIC.

SECTION I.

Of Decimal Fractions.

IN DECIMAL ARITHMETIC, the Integer or whole thing, whether Degree, League, Mile, Month, Week, Day, or Hour, is divided (or ſuppoſed to be divided) into ten equal Parts, and each Part into ten more, and ſo on *ad infinitum*; increaſing from *Unity* towards the Left Hand, and decreaſing towards the Right Hand, in a *tenfold* Proportion.

It is to be obſerved further, that, the Figures of the Numerator are only expreſſed, the Denominator being always underſtood to conſiſt of an Unit, with one or more Cyphers annexed; according as there are Places in the Numerator.

Decimal Parts are diſtinguiſhed from an Integer, or whole Number, by having a Comma prefixed, thus, ,4 ſtands for four Tenths or $\frac{4}{10}$; ,45 for Forty-five—Hundreds (or $\frac{45}{100}$;) 4,07 for $4\frac{7}{100}$ &c.—But for a further Illuſtration, obſerve the following uſeful TABLE, which has been tranſmitted, from Sire to Son, ſince the Days of the learned and ingenious Mr. OUGHTRED.

	Hundreds of Thouſands.	Tens of Thouſands.	Thouſands.	Hundreds.	Tens.	Units.	Tenths.	Hundred Parts;	Thouſand Parts.	Ten Thouſand Parts.	Hundred Thouſand Parts.	
&c.	5	4	3	2	1	0,	1	2	3	4	5	&c.

It is likewiſe to be obſerved, that Cyphers on the Right Hand of Decimal Fractions, make no Alteration in their Value; but being placed on the Left Hand decreaſe it, by removing them farther from Unity, or the Place of Units; thus, ,4; or, 40; or 400; are all of the ſame Value, being equal to $\frac{4}{10}$ (or four Tenths): but ,04 is $\frac{4}{100}$; ,004 is $\frac{4}{1000}$ &c. all which, I hope, will be clearly underſtood.

A finite Decimal will end after ſome certain Number of Diviſions; but an infinite One can no where end.

A recurring or circulating Decimal, is when one or more of the Figures continually repeat; Thus 12,1555 &c. is called a ſingle Circulate: But 12,154315431 &c. is called a compound recurring Decimal.

Whenever the Reſult conſiſts of ſeveral Nines, reject them, and make the next ſuperior Place more by Unity or one; thus for 4,1999 &c. write 4,2; and for 14,999 write 15.

It will likewiſe be proper in circulating Figures to daſh the firſt thus, $4,12\dot{4}44$

SECTION II.

ADDITION of DECIMALS.

PROP. I.

To find the Sum of any given Number of DECIMAL FRACTIONS, or mixed Numbers.

RULE.

IN Addition of DECIMAL FRACTIONS, the only Difficulty (if any there be) is that of placing the Figures; but let me remind the Reader, that a proper Conſideration of the Numeration Table will remove every Obſtacle; for Tens muſt ſtand under Tens, Units under Units, &c. as will be manifeſted in the following Examples.

EXAMPLES

EXAMPLES.

	MILES.	DEGREES.
	3,432	24,623
	14,61	16,71
	36,754	30,561
	9,5	1,367
	11,316	14,15
	45,57	36,761
	71,14	9,8
	15,161	11,91
Sum	207,483	145,882

Note. When the Decimal Parts propoſed to be added, do not contain an equal Number of Figures, the Blanks may be filled up with Cyphers, and the Reſult will be the ſame.

SECT. III.

SUBTRACTION of DECIMALS.

PROP. II.

To find the Difference of any two given DECIMAL FRACTIONS, or mixed Numbers.

RULE.

SUBTRACTION of DECIMAL FRACTIONS, muſt be managed in all Reſpects as in whole Numbers, Care being had to the due placing them as ſhewn in Addition; when it ſo happens (as it frequently doth) that the upper (or greater) Quantity, hath not ſo many Decimal Places as the lower, the Defect muſt be ſupplied with Cyphers.

EXAMPLES.

From	74,132	From	44,5
Take	63,154	Take	37,32
Remains	10,978	Remainder	7,18
Proof	74,132	Proof	44,5
From	0,4178	From	312,
Take	0,1381	Take	83,473
Remainder	0,2797	Remainder	228,527
Proof	0,4178	Proof	312,

Theſe Examples being well underſtood, will, it is preſumed, be ſufficient for the *Learner's* Purpoſe.

SECT. IV.

MULTIPLICATION of DECIMALS.

PROP. III.

To find the Product of any two given DECIMAL FRACTIONS, or mixed Numbers.

RULE.

LET the greater Number be multiplied by the leſſer, and when the Work is finiſhed (which is performed as in whole Numbers) point off as many Places towards the Right Hand, as there are Decimal Places, in both the Multiplicand and Multiplier; But ſhould it ſo happen, when the Operation is over, that there are not ſo many Places in the Product, then the Defect muſt be ſupplied by prefixing Cyphers.

EXAMPLES.

Let it be required to multiply 3,4712 by 2,54.

3,4712
2,54

138848
173560
69424

Product 8,816848

Let it be required to multiply 121,42 by 33,5.

121,42
33,5

60710
36426
36426

Product 4067,570.

Let it be required to multiply 74,363 by 274.

74,363
274

297452
510541
148726

Product 20275,462

Let 31468 be required to be multiplied by ,0452.

31468
,0452

62936
157340
125872

Product 1422,3536

Let ,16234 be given to be multiplied by ,34725.

,16234
,34725

81170
32468
113638
64936
48702

Product ,0563725650

In the laſt Example, from a Defect in the Product, a Cypher was prefixed according to the general Rule.

Given ,0246 to be multiplied by ,0478.

,0246
,0478

1968
1722
984

Product ,00117588.

If any Number of Decimals be required to be multiplied by 10, 100, 1000, 10000, &c. you need only remove the ſeparating Point, or Comma, ſo many Places towards the Right Hand, as there are Cyphers in the Multiplier.

Thus 6,72 × 10 = 67,2.
,4378 × 100 = 43,78.
,7132 × 1000 = 713,2.
,7561 × 10000 = 7561.

CONTRACTIONS.

When the Decimal Places of both Factors are large, and of Courſe would make many Decimals in the Product; the Work may be much ſhortened, by ſetting the Unit's Place of the Multiplier directly under that Part of the Multiplicand, whoſe Place you would preſerve in the Product, placing the Multiplier in an inverſe Order.

In multiplying, always begin at that Figure of the Multiplicand, which ſtands over the Figure you are multiplying by, ſetting down each particular Product directly under one another: at the ſame time Care muſt be had to the Increaſe that would ariſe from multiplying the Right Hand Figures; beginning at the End of the Line, and carrying for 5, *one*; for fifteen, *two*; for twenty-five, *three*, &c. till you come to that particular Figure from which Part of your Product is to be derived.

EXAMPLE

EXAMPLE.

Required the Product of 37,365427 by 25,6473, and let there be only four Decimals in the Product.

```
        37,365427
          3746,52
      ------------
        7473085 .
        1868271 . .
         224193 . . .
          14946 . . . .
           2616 . . . . .
            112 . . . . . .
      ----------------------
Product 958,3223 . . . . . .
      ----------------------
```

The ſame by the common Method.

```
             37 , 365427
                  25,6473
             ------------
            112 | 096281
           2615 | 57989
          14946 | 1708
         224192 | 562
        1868271 | 35
        7473085 | 4
       ------------------
Product 958,3223 | 158971
       ------------------
```

Thus, the Reader will obſerve, that theſe two Examples prove each other, to a great Degree of Exactneſs; nevertheleſs, it is not ſafe, to uſe it on all occaſions, ſave in Trigonometry, &c. where the natural Sines and Tangents may be concerned.

SECT.

SECT. V.

DIVISION of DECIMALS.

PROP. IV.

Two DECIMAL FRACTIONS, or mixed Numbers being given, to find how often the one is contained in the other.

RULE.

DIVIDE as in whole Numbers, and when the Work is finiſhed, point off as many Decimal Places in the Quotient as the Dividend exceeds the Diviſor; for the Quotient and Diviſor (together) muſt contain as many Decimal Places as the Dividend.

Should the Diviſor contain more Decimal Places than the Dividend, the latter may be ſupplied with Cyphers, and the Quotient in that Caſe will become a whole Number.

It will ſometimes happen, that when the Work is finiſhed, the Quotient is defective, *i. e.* that it doth not contain ſo many Decimals as the Dividend exceeds the Diviſor; this Defect may be remedied by prefixing Cyphers, as ſhewn in Multiplication; by which Rule all Operations in Diviſion may be proved.

EXAMPLE

EXAMPLE.

Let it be required to divide ,64327136 by ,23.

```
Diviſor. Dividend. Quotient.
 ,23) ,64327136 (2,796832
       46
       ——
       183
       161
       ———
       •222
        207
        ———
        •157
         138
         ———
         •191
          184
          ———
         • • 73
             69
            ———
           • 46
             46
            ———
            • •
```

The young Reader will perceive, from this Example, that there are ſix Decimal Places in the Quotient; as the Dividend exceeds the Diviſor by that Number.——And he will likewiſe perceive, that in caſe there had been an equal Number of Decimals in each, the Quote muſt have been a whole Number.

EXAMPLE II.

Let it be required to divide 546,3451 by 4,3262, and to have ſix Places of Decimals in the Quotient.

OPERATION.

```
4,3262) 546,3451000000 (126,287527, &c. Anſwer.
        43262
        ---------
        113725
         86524
        ---------
         272011
         259572
        ---------
        . 124390
           86524
         ---------
           378660
           346096
         ---------
          . 325640
            302834
           ---------
           . 228060
             216310
            ---------
            . 117500
               86524
             ---------
               309760
               302834
             ---------
              . . 6926 Remainder.
```

It is obvious from the above Example, that without adding Cphers to the Dividend, the required Number of

Decimals could not have been obtained; becauſe the Dividend and Diviſor contained each an equal Number; and by thus adding of Cyphers to the Remainder, the Quotient may be carried to what Length, or Number of Places you pleaſe.

EXAMPLE III.

Let it be required to divide 6,75468912 0 by 156,36.

OPERATION.

```
156,36) 6,754689120 (,0431995, &c.
         6 2544
        ------
        • 50028
          46908
        -------
         •31209
          15636
         -------
          155731
          140724
          -------
           150072
           140724
           -------
          • • 93480
               78180
           -------
              15300 Remainder.
```

In the above Example it appears that the Quotient at the End of the Operation, did not contain a ſufficient Number of Decimal Places; therefore, according to the Rule, the Defect is ſupplied by prefixing a Cypher.

If any Number of Decimals is required to be divided by 10, 100, 1000, 10000, &c. it is done by removing the ſeparating Point, or Comma, in the Dividend, ſo many Places towards the Left Hand, as there are Cyphers in the Diviſor:—for the Converſe of which, ſee Page 8th in Multiplication.

CONTRACTIONS.

Should it ſo happen, that the Diviſor conſiſts of many Places of Decimals, the Work may be much ſhortened, and the Quotient near enough the Truth.

RULE.

HAVING determined the Value of the Quotient Figures, proceed as uſual; but for every Figure afterward, prick off one in the Diviſor, having due Regard to the Increaſe which would ariſe in the Figures ſo omitted, as ſhewn in Multiplication.

EXAMPLE I.

Let it be required to divide ,0563725650 by ,34725.

OPERATION.

```
,34725) ,0563725650 (,16234 nearly
 ....:.   34725
          -----
          21647 .
          20835 .
          -----
          . 812 . .
            695 . .
            -----
            117 . . .
            104 . . .
            ---------
           . 13 . . . .
             14
            ---------
```

The ſame by the common Method.

```
,34725) ,0563725650 (,16234.
         34725
         -----
         21647 | 5
         20835 | 0
         ---------
        ..,812 | 56
           694 | 50
         ---------
           118 | 065
           104 | 175
         ---------
           .13 | 8900
            13 | 8900
         ---------
            .. | ....
```

Note, This is a Proof to Example 5th, in Multiplication.

EXAMPLE

EXAMPLE II.

Divide 958,3223158971 by 25,6473.

OPERATION.

```
25,6473) 958,3223158971 (37,365427
.. ....  769419
         -------
         1889033
         1795311
         -------
         ..937221
           769419
           -------
           167802 .
           153884 .
           --------
            13918 . .
            12824 . .
            ----------
             1094 . . .
             1025 . . .
             -----------
             ..69 . . . .
               51 . . . .
               ------------
               18 . . . . .
               18 . . . . .
               ------------
               . . . . . . .
               ------------
```

SECT. VI.

REDUCTION of DECIMALS.

PROP. V.

To reduce Vulgar FRACTIONS into DECIMALS.

RULE.

ANNEX as many Cyphers to the Numerator as you would have Decimal Places; then divide by the Denominator; the Quotient (if there be no Remainder) will be the Decimal Fraction equal to the Vulgar Fraction given: But when there is a Remainder, you may, by adding Cyphers, approach to what Nearneſs you pleaſe.

EXAMPLES.

Required the DECIMAL FRACTIONS anſwering to $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$.

$$\text{Thus}\left\{\begin{array}{l} \frac{1}{4} = \frac{1{,}00}{4} = {,}25;\ \text{For As } 4 : 1 :: 100 : 25 \\ \frac{1}{2} = \frac{1{,}0}{2} = {,}5; \text{——— As } 2 : 1 :: 100\ 50. \\ \frac{3}{4} = \frac{3{,}00}{4} = {,}75; \text{——— As } 4 : 3 :: 100 : 75. \end{array}\right.$$

What are the Decimals anſwering to $\frac{5}{8}$?

Thus $\frac{5}{8} = \frac{5,00}{8} = ,625$ Anſwer.

And $\frac{2}{7} = \frac{2,000000}{7} = ,285714,$ &c.

PROP. VI.

To Reduce, Coin, Weight, Meaſure, Time, &c. into DECIMAL FRACTIONS.

RULE

WHEN there are two or more different Denominations given to be reduced into Decimals; whether Coin Weight, Meaſure, &c.——FIRST, let theſe Denominations be reduced to the loweſt Name mentioned; which will be the Numerator of a Vulgar Fraction whoſe Denominator will be the given Integer, reduced into the ſame Denomination as the above mentioned Numerator; this Vulgar Fraction reduced (by Rule, Prop. V.) will give the Decimals required.

EXAMPLES.

Reduce 6s. 8d. to the Decimal of a Pound.

Here 6s. 8d. is equal to 80 Pence, the Numerator; and 20 Shillings (the Integer) reduced into Pence will be equal 240 the Denominator; then $\frac{80}{240}$ being reduced by (Prop. V.) will become, ,3333, &c.

OPERATION.

OPERATION.

```
40) 80,000 (,3333, &c. ad infinitum.
    720
    ———
    .800
     720
     ———
     .800
      720
      ———
      .800
       820
       ———
       .80
```

EXAMPLE II.

Reduce 16s. 4½d. to the Decimal of a Pound.

Thus 16s. 4½d. = 16 × 12 + 4 × 4 + 2 = 786 qrs in the given Sum; and thoſe being divided by 960, the Farthings in one Pound, will produce ,81875 Decimals accordingly.

EXAMPLE III.

Reduce 8oz. 16dwts. to the Decimal of a lb. Troy.

Thus 8 × 20 + 16 = 176 dwts. and 176 ÷ 240 (the dwts. in one Pound Troy) will produce ,73333, &c. Anſwer.

EXAMPLE

EXAMPLE IV.

Reduce 4 Months, 3 Weeks and 5 Days to the Decimal of a Year.

Thus $4 \times 4 + 3 \times 7 + 5 = 138$, which, being divided by 365, the Days in one Year, will give ,37808219, &c. Decimals required.

Reduction of different Denominations may be performed otherwiſe.—Thus.

4	2 Quarters.
12	4,5 Pence.
2'0	1'6,375 Shillings.
	,81875 of a Pound, ſame as Example 2d.

The above being ſo plain, that more Examples in this Propoſition, would be needleſs, let us therefore paſs to Prop. 7.

PROP. VII.

To find the Value of a given DECIMAL FRACTION.

RULE.

MULTIPLY the given DECIMAL by that Number (of the next lower Denomination) which expreſſes the Value of the Integer, of which the given Decimal Fraction is a Part; and from the Product, point off the Decimal Places as hath been ſhewn in Multiplication; and the Value of the given Decimal will be obtained, in the Name of the Multiplier; proceeding in the ſame Manner through every lower Denomination, the Value of the propoſed Decimal Fraction will be obtained—and is the Converſe of Prop. 6.

EXAMPLE

EXAMPLE I.

Required the Value of ,41666 of a Pound Sterling.

OPERATION.

,41666
20

8,33320
12

3,99840
4

3,99360 Anſwer 8s. 3¾d. almoſt 8s. 4d.

EXAMPLE II.

Required the Value of ,81875 of a Pound Sterling.

OPERATION.

,81875
20

16,37500
12

4,50000
4

2,00000 Anſwer 16s. 4½d.

EXAMPLE III.

Required the Value of ,46784 of a Day.

OPERATION.

OPERATION.

```
,46784
    24
------
187136
93568
--------
11,22816
      60
--------
13,68960
      60
--------
41,37600
      60
--------
22,5600
     60
-------
33,6000
     60
-------
36,0000
```

Hence it appears that ,46784 of a Day, is equal to 11 Hours, 13 Minutes, 41 Seconds 20 Thirds 33 Fourths and 36 Fifths of Time.

EXAMPLE IV.

Required the Value of ,5842 of a Degree.

OPERATION.

OPERATION.

```
 ,5842
    60
 ------
35,0520
      8
 ------
 ,4160
    40
 ------
16,6400
```

,5842

2345

Here the Anſwer is 35 Miles and $16\frac{64}{100}$ Perches.

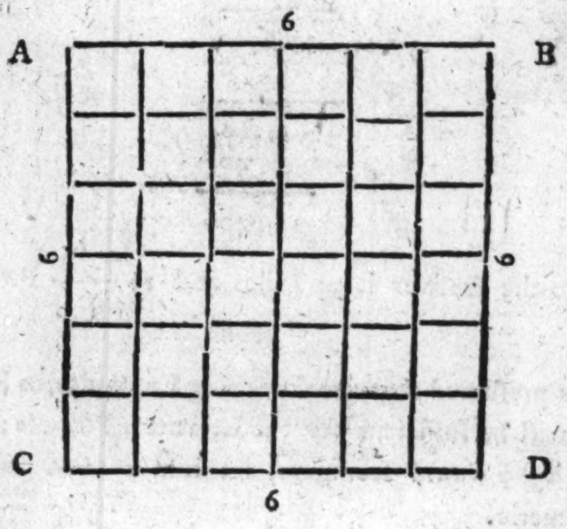
It is preſumed that the foregoing Examples in Reduction, will be ſufficient for the Learner's Purpoſe; however, if he would ſee more, let him conſult Books of Arithmetic.

SECT. III.

Of the *Extraction* of the SQUARE ROOT.

EXTRACTING the SQUARE ROOT of any given Number, is to find ſuch a Number (if poſſible) as being multiplied into itſelf; the Product will be equal to the given Number.

Thus we find that the Square Root of 36 is 6; and 6 multiplied into itſelf is 36—the given Number.—Demonſtrated further in the following Figure, where each Side contains 6 equal Parts, whence the great Square ABCD is ÷ed into 36 ſmall Squares.



It is likewiſe neceſſary that the Learner be well acquainted with the following ſmall TABLE of the Nine DIGITS and their SQUARES.

ROOTS.	1	2	3	4	5	6	7	8	9
SQUARES.	1	4	9	16	25	36	49	64	81

R U L E.

Firſt, Point the given Number (whoſe Root is required) into Periods of two Figures each, beginning at the Right Hand.

Second, Find by the Table, the greateſt Square contained in the firſt Period towards the Left Hand; under which let it be placed, and its Root in the Quotient, (as in Diviſion) ſubtract that Square from the Period under which it ſtands, and to the Remainder bring down the next Period for a new Dividend.

Third, Double the Root already found, and place it on the Left for a Diviſor; find how often this Diviſor is contained in the ſaid Dividend (reſerving the Unit's Place) and put the Anſwer in the Quotient, and alſo on the Right of the Diviſor; This done, multiply the Diviſor by the laſt Figure put in the Quotient; the Product ariſing therefrom, ſubtract from the Dividend; to the Remainder bring down the next Period, and proceed in all Reſpects as before.

Note, In pointing off Decimals, remember that the Decimal Places be made even, by annexing Cyphers, ſo that a Point may fall over the Unit's Place of the Integer.

EXAMPLE I.

Let it be required to extract the Square Root of 3844;— or which is the ſame, to find a Number (if poſſible) which being multiplied into itſelf, ſhall be equal to 3844.

OPERATION.

```
       '. .
       3844  (62 Root, or Number required.
       36     62
       ----  ----
122)   244   124
       244  372
       ----  ----
       ...   3844 Proof.
```

EXAMPLE II.

Required the SQUARE ROOT of 12321?——

OPERATION.

```
        12321  (111 Root sought.
        1
       ----
  21 | .23     for 111 ×ed by 111 = 12231.
  +1    21
 ----  ----
 221 | .221
        221
        ...
       ----
```

EXAMPLE III.

Required the SQUARE ROOT of 5432,5604.?——

OPERATION.

```
              5432,5604  (73,7059, &c. Root.
              49
              ----
143)   |  .532
+3         429
---------------
1467   | 10356
 +7      10269
------------------
147405    ..870400
    +5      737025
---------------------
1474109 | 13337500
          13266981
---------------------
          ...70519 Remainder.
---------------------
```

Note, The Places in the Root, may be determined, by obſerving the Points in the Dividend; for it will always conſiſt of the like Number.——In the laſt Example the Dividend being a Surd, cannot have its Root exactly extracted; but by adding Cyphers, we may approach to a great Degree of Exactneſs.

EXAMPLE IV.

Required the SQUARE ROOT of 2?——

OPERATION.

OPERATION.

2.00000000 (1,4142, &c. the Root nearly.
1

24) 100
+4 96

281) .400
+1 281

2824) 11900
+4 11296

28282) ..60400
56564

.3836 Remainder.

Of the Uſe of the SQUARE ROOT.

PROP. I.

To find a mean Proportional betweeen any two given Numbers.

RULE.

Let the given Numbers be multiplied together, and the Square Root of the Product will be the mean Proportional.

EXAMPLE I.

Required the mean Proportional between 4 and 9?

OPERATION.

OPERATION.

Firſt $4 \times 9 = 36$; and $\sqrt{36} = 6$, the Mean required.

Required the mean Proportional between 4 and 64?

According to the Rule, it will be found to be—16,
For As $4 : 16 :: 16 : 64$.

PROP. II.

To find the Side of a Square equal in Area to any given Superficies.

RULE.

The SQUARE ROOT of the given Superficies, will be the Side of a Square required.

EXAMPLES.

Suppoſe the Area of a Circle be 5184, I demand the Side of a Square, whoſe ſuperficial Content ſhall be equal to the given Circle.

By working, according to the Rule, the Anſwer will be 72.———for $72 \times 72 = 5184$.

PROP. III.

The Area of a Circle being given to find its Diameter.

RULE.

Multiply the SQUARE ROOT of the Area by 1,12837, and the Product will be the Anſwer.

EXAMPLE.

Required the Diameter of a Circle whoſe Area is 256.

Now $\sqrt[2]{256} = 16$, and $16 \times 1,12837 = 18,05392$ the Diameter ſought.

PROP. IV.

The Area of a Circle being given to find its Circumference.

RULE.

Multiply the ſquare Root of the Area by 3,5449, and the Product will give the Circumference.

EXAMPLE.

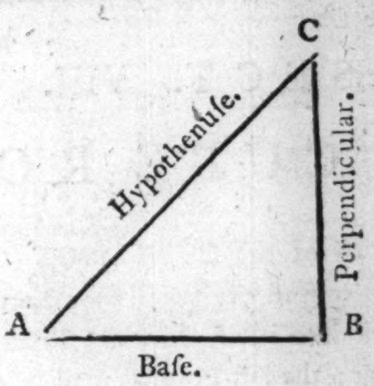
When the Area of a Circle is 100, what is the Circumfernce ?

Thus, $\sqrt{100} = 10$, which, multiplied into the common Factor, will produce 35,449 for the Circumference.

PROP.

PROP. V.

Any two Sides of a right-angled Triangle, A B C, being given, to find the third Side.



Firſt, When the Baſe and Perpendicular are given to find the Hypothenuſe.

RULE.

Square each Side, add the Squares together, and the ſquare Root of this Sum, will give the Hypothenuſe.

Second, When the Hypothenuſe, and one Side are given, to find the other Side.

RULE.

RULE.

From the Square of the Hypothenuſe, ſubtract the Square of the given Side, andt he Square Root of the Remainder will give the Side required.

SECT. VIII.

Of the CUBE ROOT.

EXTRACTION of the CUBE ROOT of any given Number, is to find (if poſſible) a Number, which, when multiplied into itſelf, and the Product again by the ſaid Number; the laſt Product ſhall be equal to the given Number.

Thus, the Cube Root of 8 is 2; and 2 × 2 × 2 gives 8; ſee the following Table,—which muſt be got by Heart.

Roots.	1	2	3	4	5	6	7	8	9
Cubes.	1	8	27	64	125	216	343	512	729

A GENERBL RULE for the EXTRACTING the ROOTS of all POWERS.

Firſt, Prepare the given Number for Extraction, by pointing it into Periods, of two, three, four, &c. according to the Index of the required Root,—taking Care that the Decimal Places be compleat Periods, by adding Cyphers if need be.

Second, Find the firſt Figure in the Root by the Table of Powers, which ſubtract from the given Number; to the Remainder bring down the firſt Figure of the next Period, for a Dividend.

Third, Involve the Root, already found, into the next inferior Power to that which is given; multiply it by the given Power, and call it a Diviſor; by which divide the Dividend, and the Quote will be the ſecond Figure of the Root.

Fourth, Involve the Root, into the given Power, which call a Subtrahend.

Fifth, Take the Subtrahend from the Figures of the two firſt Periods, and proceed as before for a Dividend

Sixth, Find a new Diviſor, &c.

EXAMPLE I.

What is the Cube Root of 1404,928?

OPERATION.

OPERATION.

. . .
1404,928 (11,2 Root required.
1
Diviſor 3) 4 Dividend
1331 Subtrahend
Diviſor 363) ..639 Dividend
1404,928 Subtrahend
....

1 × 1 × 3 = 3 Diviſor
11 × 11 × 11 = 1331 Subtrahend
11 × 11 × 3 = 363 Diviſor
112 × 112 × 112 = 1404,928 Subtrahend.

Required the Cube Root of 172800?

OPERATION.

. . .
1728000 (120 Root.
1
3) .7 Dividend.
1728 Subtrahend.
432) ....0 Dividend.
1728000 Subtrahend.

Of

Of the Use of the CUBE ROOT.

Prop. I.

To find the Side of a Cube that ſhall be equal in Solidity to any given Solid, whether Globe, Cylinder, Priſm, &c.

RULE.

Extract the Cube Root of the ſolid Content of the given Body, which Root will be the Side of the Cube required.

EXAMPLE.

What is the Side of a Cube, that ſhall be equal to a Globe of 551368 ſolid Feet.

$$\sqrt[3]{551368} = 682$$ the Side required.

Prop. II.

The Side of a Cube being given, to find the Side of a Cube that ſhall be double, treble, &c. in Quantity to the given Cube.

RULE.

Cube the given Side, and multiply it by 2, 3, &c. the Cube Root of the Product will give the required Side.

EXAMPLE.

EXAMPLE.

I demand the Side of a Cubical Veſſel that ſhall hold three Times the Quantity of another, whoſe Side is three Feet.

$\sqrt[3]{27 \times 3} = 4,3267$, &c. the Side required.

Should the foregoing general Rule be thought tedious, the following one (taken from Dr. HUTTON's excellent Treatiſe on Arithmetic) may be made Uſe of, and will be found extremely ready in Practice.

RULE II.

To extract the CUBE ROOT.

I. By Trials, take the neareſt rational Cube to the given Cube or Number, and call it the aſſumed Cube.

II. Then the Sum of the given Number, and double the aſſumed Cube will be to the Sum of the aſſumed Cube and double the given Number, as the Root of the aſſumed Cube, is to the Root required nearly.—Or, as the firſt Sum is to the Difference of the given and aſſumed Cube, ſo is the aſſumed Root, to the Difference of the Roots nearly.

III. Again, by uſing, in like Manner, the Cube of the Root laſt found as a new aſſumed Cube, another Root will be obtained ſtill nearer, and ſo on as far as we pleaſe; uſing always the Cube of the laſt-found Root, for the aſſumed Cube.

EXAMPLE.

EXAMPLE.

To find the Cube Root of 81.

Here we ſoon find by the Table, that the Root lies between 4 and 5, and then between 4,3, and 4,4; taking therefore 4,3, whoſe Cube is 79,507, the aſſumed Cube;

Then 79,507   81
2   2

159,014   162
81   79,507

As 240,014 : 241,507 :: 4,3 : 4,326743 the Root nearly.

Again, for a ſecond Operation, the Cube of this Root is 80,99967926210609 4407, and the Proceſs by the latter Method will be thus:

80,9996792621, &c.
2

161.9993585242   81
81   80,9996792621, &c.

As 242,9993585242 : Diff. ,0003207379 :: 4326743 :
Diff. 0000057,&c:

Conſequently the Root is 4,3267487,&c.

What is the Cube Root of ,0081? —Anſwer ,20082, &c.
What is the Cube Root of 2? ——Anſ. 1.2599210, &c.
What is the Cube Root of 39304? —Anſwer 34.
What is the Cube Root of 3375? —Anſwer 15.

More Rules and Examples might have been added, but thoſe already given, are, it is preſumed, ſuch as will prove ſufficiently uſeful in moſt of the Concerns of life; and as ſuch, will anſwer the Purpoſe of this Introduction.

A KEY TO GEOGRAPHY;

OR, A

Complete GUIDE to the USE of the GLOBES.

PART I.

Containing a Deſcription of the GLOBES, with all the neceſſary Definitions, GEOGRAPHICAL and ASTRONOMICAL.

Of the GLOBES in general.

A GLOBE, as to its Name and Figure, is ſo univerſally known, that to give a Mathematical Definition thereof will be needleſs; however, of the Parts appertaining thereto, a Deſcription will be neceſſary.

Of

Of the real PARTS and their USES.

I. GLOBES are of two Sorts, *viz.* TERRESTRIAL and CELESTIAL, being Emblems of the Earth and Heavens.

The Terreſtrial GLOBE hath on its Body, the whole Form and Faſhion of the Earth and Sea deſcribed, with ſeveral Circles of the Sphere;—ſuch as the Equator, Ecliptic, Meridians, Parallels, Tropics, &c.

The Celeſtial GLOBE repreſents the Starry Firmament, or glorious, glowing, Canopy of Heaven; on which are the ſeveral Conſtellations as pictured by the Ancients, under the Figures of Men, Beaſts, Birds, Fiſhes, &c. and from which the principal Stars derive their names, and upon which their ſeveral Places are made to correſpond with the real Places of thoſe Stars in the Heavens: with this difference only, that in the Heavens they appear fixed in a Concave Sphere; but are here upon a Convex *one.*

However, to render this agreeable, let the Pupil imagine himſelf removed beyond the Stars; or that the artificial GLOBE was tranſparent, and himſelf ſeated in the Centre, (as the Earth is repreſented in an Armillary Sphere) he will then, in either Caſe, ſee the heavenly Bodies, in the ſame Situation, as they really appear in that beauteous ſpangled Arch.

The HORIZON; This is a broad flat Piece of Wood circumſcribing the Globe, and is called the true, rational and aſtronomic Horizon: Its Uſe is to divide the Globe into two equal Parts, called the upper and lower Hemiſpheres; alſo it ſerves to determine the riſing and ſetting of the Sun, Moon, and Stars; with the Length and Increaſe of Day and Night in all Parts of the Earth.

On the Horizon are ſeveral Circles, with which the Pupil muſt be well acquainted; ſuch as the Circle of Months; of the Days in each Month, as they ſtand in the Calendar; of the 12 Signs of the Zodiac, with the Degrees in each, anſwering to the Days of the Year when the Sun preſides in thoſe Signs, &c. Within the Signs is a Circle containing the 32 Winds or Points of the Compaſs; called alſo Rhumbs, each Point having its Name expreſſed by initial Letters.

The laſt and inmoſt Circle, is divided into Degrees, (and thoſe ſubdivided for the greater Accuracy) beginning at the Eaſt and Weſt Points, and are numbered both ways towards the North and South Points; each Quadrant containing 90 Degrees, in all 360.

On this Circle the Azimuths of the Sun, Moon, and Stars are reckoned, as alſo their Amplitudes: the Angle of Poſition, on the Terreſtrial Globe, is counted on this Circle.——Upon Senex's Globes, and ſome others, there are two of thoſe Circles; the one for the Azimuths, and Angles of Poſition; the other for the Amplitude; the former counted from the North and South, the latter from the Eaſt and Weſt; though their ſeveral Uſes are ſufficiently anſwered by one.

III. The BRAZEN MERIDIAN. This is a ſtrong Braſs Ring in which the Globe is hung, or fixed, ſo as to turn freely on its Axis, and is divided into four Quadrants of ninety Degrees each; two of which begin at the Equator, and are numbered with 10, 20, 30, &c. towards either Pole, to ſhew the Latitude of Places on the Terreſtrial Globe, and the Declination of the Sun, Moon, and Stars on the Celeſtial Globe:—the other two begin at the Poles, and are numbered towards the Equator, which ſerve in elevating the Pole to the Latitude of a Place, to which it will always be equal.

It alſo ſerves to divide the Globe into two equal Parts called the Eaſtern and Weſtern Hemiſpheres.

IV. The QUADRANT OF ALTITUDE. This is a pliant Plate of Braſs, anſwering to a Quadrant of the Brazen Meridian, and, like it, is divided into Degrees, &c. according to the Size of Globes; (the Beſt for Scholaſtic Uſe, being thoſe of 12 or 15 Inches in Diameter):——The Quadrant, when fixed to the Braſs Meridian by a Screw in the Zenith, ſerves to determine the Diſtance of Places on the Terreſtrial Globe; and the Altitudes, Azimuths, Almicanthers, Diſtances, &c. on the Celeſtial Globe.

V. HOARY CIRCLE and INDEX. This is a round flat Ring of Braſs, and is generally fixed on the North Pole of the Globe, becauſe moſt frequently uſed in Northern Latitudes: On this Ring are engraved twice 12 or 24 Hours, anſwering to the Hours of the natural Day; each Hour being divided into Halves, Quarters, &c.—the uppermoſt 12 repreſenting Noon, the undermoſt 12 at Night, or Midnight;—thoſe on the Eaſtern Side are the

Morning

Morning Hours, and thoſe on the Weſtern Side the Evening Hours.

Each Hour anſwers to 15 Degrees of the Equator, and each Degree of the Equator to 4 Minutes of Time.

The hoary Circle ſerves to ſhew the Time of the riſing, ſouthing, and ſetting of the Sun, Moon, and Stars; the beginning and ending of Twilight; the Difference of Time between all Places of the Earth, &c.—the Index being carried round by the Motion of the Globe, upon the Axis of which it is placed, yet may be turned to what Place we pleaſe, without moving the Globe.

Note, On ſome modern Globes there is engraved two Hour Circles, one on the North, and the other on the South Pole, which are divided into twice 12 Hours, and numbered round from Eaſt to Weſt, and the contrary, with a double Row of Figures, the Meridian of London paſſing through both the 12 Hours;—the Index, or Hour Hand, is placed under the Brazen Meridian, and is moveable at Pleaſure to any Part of the Hour Circle required, and will remain there during the Revolution of the Globe on its Axis.—This ſeems to have originated with the late ingenious Mr JOSEPH HARRIS, and lately improved by Mr. GEORGE WRIGHT;—is extremely uſeful in tracing the Tracts of Captain Cook, and other Navigators, and ready in ſolving all Problems wherein Time is concerned; ſhewing at once the Hour and Complement thereof to 12—with ſeveral other pretty Concluſions, by the further Addition of a Braſs Semi-circle, moveable on the Eaſt and Weſt Points of the Paper Horizon.

VI. The Braſs Semi-circle of Poſition.—This is a thin Plate of Braſs, divided into 180 Degrees; its Uſe is (but it is never made unleſs beſpoke) to meaſure the Diſtance of Places on the Terreſtrial Globe, &c.—the Quadrant of Altitude ſupplies its Place, and is preferable in Practice.

VII. The MARINER's COMPASS.—This is uſeful in placing the Globe due North and South, when we would repreſent the Face of the Earth or Heavens, at any given Hour; (allowing for the Variation)—the beſt Place for fixing it being upon the Horizon, or immediately under it, at the North Point.

Theſe are the real Parts which compoſe this uſeful Inſtrument; it will now be neceſſary to deſcribe the imaginary Ones.

Of the imaginary PARTS and their USES.

I. The EQUATOR.—This is a great Circle equally diſtant from the Poles: it is not ſo termed, merely from dividing the Globe into two equal Parts, (for the other great Circles might claim the ſame Denomination;) but that the Sun coming upon the Equinoctial, and immediately over this Line, the Days and Nights become equal to all the Inhabitants of the Earth; it is called the Equinoctial Line, and ſo well is it known by Navigators, that by them its common Appellation is the LINE.

The Equator or Equinoctial is divided into 360 Degrees, and is the Standard of all Meaſures.

Its Uſe is to divide the Globe into two equal Parts, called the Northern and Southern Hemiſpheres; to mark the true Points of Eaſt and Weſt in all Countries round the Globe; to determine the Courſe and Meaſure of the Parallels;—it ſerves as the Baſis for finding, and reckoning the Latitudes.

On the Terreſtrial Globe this Circle is divided into twice 180 Degrees, numbered Eaſtward and Weſtward, from the firſt Meridian (which in England paſſeth through London in Honour of the Place) till the Reckonings end on the oppoſite Side of the Globe.

On the Celeſtial Globe the Degrees are counted from the Beginning of Aries ♈, where the Ecliptic and Equinoctial interſect each other, all round till they end at the ſame Place;—and upon which the Right and Oblique Aſcenſions of the Sun and Stars are found.

II. The ECLIPTIC.——This is a great Circle, and ſignifies the Line of Eclipſes, becauſe all the Eclipſes of the Sun and Moon happen in it.

This is the common Path of the Sun, and contains the 12 Signs of the Zodiac, named from ſo many different Animals; to each of which, is aſſigned a twelfth Part, containing 30 Degrees; their Names and Characters are as under.

Aries,	Taurus,	Gemini,	Cancer,	Leo,	Virgo,
♈	♉	♊	♋	♌	♍

Libra,	Scorpio,	Sagittarius,	Capricornus,	Aquarius,	Piſces.
♎	♏	♐	♑	♒	♓

The firſt Six are called *Northern Signs*, as lying on the North Side of the Equinoctial, and the laſt *ſix*, *Southern Signs*, for the ſame Reaſon that they are on the South Side of the Equinoctial.

It is obſerved, that in March and September the Days lengthen or ſhorten much; this is owing to the Obliquity of the Ecliptic;——and the contrary happens in June and December, becauſe of its Paralleliſm.

III. ZODIAC. This is a great Circle 16 Degrees in Breadth, and is the only one in the Heavens, that admits of Latitude, in which the 12 Conſtellations are placed, which give Names to the 12 Signs: the whole Motion of the Planets is performed in this Circle, in the Centre of which is the Ecliptic, or the Sun's high Road above deſcribed.

IV. The HORIZON, is a Circle drawn round any given Place on the Surface of the Earth.

There are different Horizons, *viz.* Senſible and Rational.——The Senſible or apparent Horizon is ſo called becauſe it ſeems to divide the Earth from the Heavens, and the viſible Part of each from the inviſible; or, in other Words, is a Boundary to the Sight of every Spectator.

The Rational or aſtronomic Horizon, is ſo called, becauſe it is comprehended by our Reaſon, and is repreſented on the artificial Globe by the wooden Horizon.

Both Horizons have the ſame Poles, which are the Zenith and Nadir Points.

They differ in ſeveral Reſpects;——the Rational divides the Globe into two equal Parts, the Senſible into two unequal ones.

The Semi-diameter of the Rational is equal to the Semi-diameter of the Earth; but that of the Senſible not 3 Miles at the Height of five Feet.

To ſuch of my Readers as have made themſelves acquainted with the Square Root, it is apprehended that the following *Theorem*, illuſtrated by an *Example*, will be highly ſatisfactory, (ſuppoſing the Earth to be perfectly ſpherical, and that the viſual Rays were to come uninterrupted to the Eye.)——

Let the Diameter of the Earth which is 7970 Miles be reduced into Feet, and we ſhall have $42081600 = a$; the height of the Eye above the Surface of the Earth $= b$; hence we have this Theorem, *viz.* $\surd\,\overline{a + b \times b} =$ the Semi-diameter, of the ſenſible Horizon.

EXAMPLE.

Required the Semi-diameter of the ſenſible Horizon, the Eye being 6 Feet above the Surface.

OPERATION

OPERATION.

Feet. Yards. Miles.

$\sqrt[2]{\overline{42081600+6}\times 6}=15889,92=5296,64=3,009$ Anſ.

Otherwiſe by Logarithms (the Semi-diameters of the Earth, and Height of the Eye, being conſidered as the Sides of a plain Triangle.)

RULE.

Add together the Logarithms of the Sum of the two Semi-diameters of the Earth, with the Addition of the Height of the Eye above the Surface; and to theſe the Logarithm of the Difference of theſe Sides: half the Sum of theſe Logarithms will be the Logarithm of the Semi-diameter of the ſenſible Horizon required.

OPERATION.

The Semi-diameter of the Earth in Yards is 7013600, and the Height of the Eye above the Surface two Yards more. The Sum of both Sides is,

14027202—whoſe Logarithm is 7,1469712
Log. of 2 Yards, (the Differ. of the Sides) ,3010300

Sum 7,4480012

The half Sum 3,7240006

is equal to 5296,64 Yards = 3,009 + Miles, as above.

The Senſible Horizon, which is generally uſed in Navigation, is divided by the Meridian into Eaſtern and Weſtern.——The Eaſtern, that Part of the Heavens where the heavenly Bodies riſe; the weſtern Horizon, where they are obſerved to ſet; it is alſo didided into four cardinal Points, viz. Eaſt, Weſt, North and South.

It muſt alſo be obſerved, that there are as many Horizons as there are Places on the Earth; for as often as we change our Place, we change our Horizon; and yet there are but three Sorts, viz. Right, Oblique, and Parallel; according to the Poſitions of the Sphere.

V. The MERIDIANS.—They are repreſented on the Globe by the brazen Meridian, although they are numberleſs; for every Place has its Meridian: When the Sun comes upon the Meridian of any Place, it is Mid-day.

One Meridian is generally choſen as chief, from which Longitude is reckoned; it is variouſly placed by Geographers; and known by being a double or treble Line; by the Engliſh it is made to paſs through London.

Thoſe Meridians which paſs through every fifteenth Degree of the Equator or Equinoctial are Hour Circles.

Thoſe which paſs through every tenth Degree, on the terreſtrial Globe, are called Circles of terreſtrial Longitude; and are divided into Eaſt and Weſt, by the firſt Meridian.

VI. COLURES.—Theſe are two Meridians cutting each other at right Angles in the Poles of the World, dividing the Equinoctial and Ecliptic into four equal Parts; the one paſſing through the Beginning of Aries and Libra, called the Equinoctial Colure, becauſe thoſe Signs are in the Equinoctial.

The other paſſing through the Beginning of Cancer and Capricorn (two Solſtitial Signs) is called the Solſtitial Colure; it alſo paſſeth through the Poles of the Ecliptic.

Note, The leſſer Circles deſcribed on Globes, are called Parallel Circles, ſome of which have Names, as Tropics and Polar Circles.

VII. The TROPICS, are *two*, being Parallel to the Equator, and diſtant from it 23° 30′ nearly; that on the North Side, is termed the Tropic of Cancer, to which, when the Sun arrives, he has the greateſt North Declination, and all Places in Northern Latitudes have their longeſt Day and ſhorteſt Night, which happens about the 21ſt of June.—The other on the South Side, at the ſame Diſtance from the Equator, called the Tropic of Capricorn, maketh the greateſt South Declination, and of Courſe the ſhorteſt Day and longeſt Night to the Northern Inhabitants, which happens about the 22d of December.

VIII. The POLAR CIRCLES are *two*, being alſo parallel to the Equator, and 66½ Degrees diſtant therefrom, or 23½ Degrees from either of the Poles;——that near the

North Pole is called the Arctic Circle, and the other the Antarctic Circle; theſe Circles are known on Globes or Maps, by being drawn double or dotted.

Moreover, theſe Circles divide the Globe into five Parts called Zones, *viz.* one Torrid, two Temperate, and two Frigid.

IX. The TORRID ZONE contains all that Space between the two Tropics, and is ſo called from the exceſſive Heat in that Region, the Sun being vertical twice a-Year to all who inhabit it; it is 47 Degrees in Breadth, and was ſuppoſed by the Ancients to be uninhabitable, but Experience has proved the contrary; being ſo fruitful in many Places, as to produce two Harveſts in a Year.

X. TEMPERATE ZONES. Theſe are ſo called from their lying between the Extremes of Heat and Cold, that is between the Tropics and the Polar Circles, being each 43 Degrees in Breadth.

XI. FRIGID ZONES. Theſe, like two Shields, incompaſs either Pole to the Diſtance of 23½ Degrees, as was ſaid above; the Ancients believed theſe Zones to be equally intolerable with the Torrid, from exceſſive Coldneſs; but the great Aſtronomer Dr. EDMUND HALLY, ſeems to aſſert, that the Weather muſt be as warm in the North Frigid Zone, when the Sun is in Cancer, as at the Equator when he is vertical;——This, however, is queſtionable.

XII. CLIMATES, or CLIMES. Theſe Tracts are bounded by imaginary Circles on the Surface of the Earth, parallel to the Equator, on either Side thereof 30;——24 of which being of ſuch a Breadth from South to North, and the contrary, that the Length of the artificial Day in one Climate exceeds that of the former by half an Hour; the other ſix by intire Months.

A TABLE of CLIMATES differing from each other by half an Hour.

Climates.	Hours.	Latitude. D.	Latitude. M.	Amplitude. D.	Amplitude. M.	Climates.	Hours.	Latitude. D.	Latitude. M.	Amplitude. D.	Amplitude. M.
1	12½	8	25	8	25	13	18½	59	58	1	29
2	13	16	25	8	0	14	19	61	18	1	20
3	13½	23	50	7	25	15	19½	62	25	1	7
4	14	30	25	6	30	16	20	63	22	0	57
5	14½	36	28	6	8	17	20½	64	6	0	44
6	15	41	22	4	54	18	21	64	49	0	43
7	15½	45	25	4	7	19	21½	65	25	0	32
8	16	49	1	3	32	20	22	65	47	0	26
9	16½	52	0	2	57	21	22½	66	6	0	19
10	17	54	27	2	29	22	23	66	20	0	14
11	17½	56	37	2	10	23	23½	66	28	0	8
12	18	58	29	1	52	24	24	66	30	0	3

CLIMATES differing by entire Months.

Months.	Lat. D.	Lat. M.	Months.	Lat. D.	Lat. M.	Months.	Lat. D.	Lat. M.
1	67	21	3	73	36	5	84	6
2	69	28	4	78	30	6	90	0

This TABLE has a two-fold Uſe; the Primary to mark the various Lengths of the Days, at certain Intervals; the Secondary to determine the Degrees of Latitude, at thoſe Intervals.

It will be eaſy, by the above Table, to find what Climate any Country is in, by means of the Column of Climates correſponding with the other Columns, which expreſs the Length of the Day, and Latitude; or without the Table, the Climate may be found by the Length of the Day; for between the Equator and the Polar Circles, there will be ſo many Climates as there are Half Hours above 12, which is the Length of the Day, at the Equator.——For Example. Suppoſe I would know what Climate London is in, where the longeſt Day is 16½ Hours?——I ſubtract 12 from 16½, and the Difference in Half Hours, viz. 9, is the Climate required.

XIII. **LATITUDE** on the **EARTH**, is an Arch of the Meridian, contained between the Equator and the given Place; to which, the Height of the Pole, above the Horizon, will always be equal; and is reckoned on the Brazen Meridian, or on the graduated *one* upon the Body of the Globe: It is either North or South, as the given Place is ſituate on the North or South Side of the Equator.

XIV. **LATITUDE** in the **HEAVENS**. This is an Arch of a Circle of Longitude, comprehended between that Point which is given, and the Ecliptic, and is counted on the Quadrant of Altitude, when ſcrewed over the Pole of the Ecliptic; it is applicable to the fixed Stars, and all the Planets, except the Sun, which, as was before obſerved, never deviates from the Ecliptic.

Note. What is here ſaid of the *Sun*, muſt be underſtood, *apparently*, for it is the *Earth*, that *really* moves in the Ecliptic—The Sun being the Centre of the Syſtem, having one Motion only, which is central, and is performed in 25¼ Days, cannot poſſibly be ſuppoſed to viſit the different Signs of the Zodiac:—tho' perhaps, to convince the Vulgar of this Error (which they have enjoyed for Thouſands of Years) would be a Taſk not eaſily performed.

It is greatly to be wiſhed, that the Generality of Youth, were inſtructed in the Uſe of the Globes, and the Principles of Aſtronomy; which are ſo eaſily attained. This would ſurprizingly enlarge the Ideas; would cauſe the Mind to expand beyond the narrow ſublunary Views of Ignorance; and greatly advance the Honour of true Religion.

XV. LONGITUDE on the **EARTH**, is an Arch of the Equator, comprehended between the Meridian of any given Place, and the firſt Meridian; (or that Meridian from whence the Longitude is reckoned;) and is either Eaſt or Weſt, as the given Place is Eaſt or Weſt of that firſt Meridian. Or it is an Angle formed at the Pole, by the firſt Meridian and the given Place.

Note. Two Places may have the ſame Longitude, yet not equally diſtant from the firſt Meridian, as may be ſeen in the following Table.

A TABLE,

Shewing the Number of Miles, and decimal Parts of a Mile, anſwering to one Degree of Longitude, in every Degree of Latitude.

D. L.	Miles	D. L.	Miles	D. L.	Miles
1	59,99	31	51,43	61	29,09
2	59,96	32	50,88	62	28,17
3	59,92	33	50,32	63	27,24
4	59,85	34	49,74	64	26,30
5	59,77	35	49,15	65	25,36
6	59,67	36	48,54	66	24,41
7	59,56	37	47,92	67	23,44
8	59,42	38	47,28	68	22,48
9	52,26	39	46,63	69	21,50
10	59,09	40	45,97	70	20,52
11	58,89	41	45,28	71	19,53
12	58,69	42	44,59	72	18,54
13	58,46	43	43,88	73	17,54
14	58,22	44	43,16	74	16,54
15	57,95	45	42,43	75	15,53
16	57,67	46	41,68	76	14,52
17	57,38	47	40,92	77	13,50
18	57,06	48	40,15	78	12,48
19	56,73	49	39,36	79	11,45
20	56,38	50	38,57	80	10,42
21	56,02	51	37,76	81	9,38
22	55,63	52	36,94	82	8,35
23	55,23	53	36,11	83	7,32
24	54,81	54	35,27	84	6,28
25	54,38	55	34,41	85	5,23
26	53,93	56	33,55	86	4,18
27	53,46	57	32,68	87	3,14
28	52,96	58	31,79	88	2,09
29	52,47	59	30,90	89	1,05
30	51,96	60	30,00	90	0,00

This TABLE is computed upon a Suppoſition, that the Earth is truly ſpherical, and by the following Proportion, as any One, who has the leaſt Knowledge of Trigonometry will eaſily prove.

Thus, As Radius :
Is to the Co-Sine, of any Latitude ::
So is the Miles in one Degree on the Equator :
To the Miles of Longitude in that Degree
of Latitude which is required.

For Example. Let it be required, to find the Number of Miles in one Degree of Longitude, in Latitude 52 Degrees, North or South.

O P E R A T I O N.

As Radius - - - - - -	1,0000000
To the Co-ſine of 52° - - -	9,7893420
So is 60 - - - - - -	1,7781513
To the Log. of 36,94 - -	1,5674933

The Table may be made to every Degree and Minute of the Quadrant, by the ſame Rule ; and may likewiſe be proved by the Line of Longitude, on Gunter's Scale.

XVI. LONGITUDE of any Point in the Heavens. This is the Quantity of an Arch, contained between the firſt Point of Aries, and a Circle of Longitude, which paſſeth through the Sun or Star, or any aſſigned Point of the Heavens, and is counted according to the Order of the Signs.

XVII. ASCENSION is the Riſing of any Part of the Equinoctial above the Horizon. *Deſcenſion* the contrary.

XVIII. RIGHT ASCENSION, is an Arch of the Equinoctial, contained between the Beginning of Aries, and the given Point, counted according to the Order of the Signs. Or it is an Angle, formed by the Equinoctial Colure at the Poles, and the Meridian, which paſſeth through any given Point, and is meaſured on the Equinoctial.

XIX. OBLIQUE ASCENSION, is that Degree and Minute of the Equinoctial (reckoned as before) which riſeth with the Centre of the Sun or Star, or any given Point in the Heavens. *Oblique Deſcenſion* the contrary.

XX. ASCENSIONAL DIFFERENCE. This is the Difference between the *Right* and *Oblique* Aſcenſion or Deſcenſion; and in regard to the Sun, is the exact Time that he either riſes or ſets, before or after Six o'Clock.

XXI. AMPLITUDE, is the Quantity of an Angle formed at the Place of Obſervation, between the

Object and the true Eaſt and Weſt Point, at its Riſing or Setting, and is counted on the Horizon, from the ſaid Points accordingly.

XXII. **ZENITH of a PLACE.** This is the Point directly over our Heads, and is the Pole of the *Horizon*, whether *ſenſible* or *rational*.

XXIII. **NADIR.** This is always oppoſite the Zenith, and is the Pole of the Horizon of an oppoſite Hemiſphere, whether ſenſible or rational.

XXIV. **AZIMUTHS, or VERTICAL CIRCLES,** are great Circles interſecting each other in the Zenith and Nadir, cutting the Horizon at Right Angles: Theſe Circles are not on the Globes, but are repreſented by the *Quadrant of Altitude*, when ſcrewed to the Zenith. Azimuth is reckoned in Degrees on the Horizon, from the North and South Points.

XXV. **PRIME VERTICAL.** This is that great Circle, which paſſeth through the Horizon at Right Angles, with the Meridian of a Place, marking thereby the true Points of Eaſt and Weſt.

XXVI. **DECLINATION,** is an Arch of the Meridian, contained between the Equinoctial, and the Object obſerved in any Point in the Heavens, and is either North or South, according as it is North or South of the Equinoctial, counted on the Brazen Meridian.

XXVII. **ALTITUDE,** is an Arch of an Azimuth, or Vertical Circle, comprehended between the Horizon and any parallel of Altitude, and is meaſured on the Quadrant.

XXVIII. **MERIDIAN ALTITUDE** of any Object, is its Altitude when on the Meridian of any given Place.

XXIX. **ZENITH DISTANCE** of any Object, is the Diſtance of any Object, from the Zenith, and is the Complement of its Altitude to 90 Degrees.

XXX. **CULMINATING** of any Heavenly Body, is the exact Time of its coming upon the Meridian of any Place, from whence it is obſerved.

XXXI. **ALMICANTHERS**, are Parallels of Altitude, or ſmall Circles, parellel to the Horizon, running through every Degree and Minute of the Meridian, whoſe Poles are the Zenith and Nadir.

XXXII. **RECESSION of the EQUINOCTIAL POINTS.** This is a ſlow Motion, which thoſe Points have, contrary to the Order of the Signs, at the Rate of 50 Seconds in a Year, or one Degree in 72 Years; by which Retrograde Motion, the whole Circle of the Signs will revolve in 25920 Years, called the Great Platonic Year; and is had by multiplying 360 by 72.

The Pupil will obſerve, that ſince Aſtronomy firſt dawned in the Eaſtern World, and was reckoned a Science fit for the greateſt Monarchs, that the Equinoctial Points have receded, or gone back, one whole

Sign; for Aries, or the Ram, will be found in Taurus; Taurus in Gemini; Gemini in Cancer, &c. as they plainly appear on the Celeſtial Globe; nevertheleſs, Aſtronomers continue the Characters in the Places wherein they were firſt obſerved, to ſhew the Aberration of the Axis of the Earth, which cauſes this wonderful Phænomena.

XXXIII. CARDINAL POINTS. Theſe are the four principal Points of the Compaſs, or Horizon, viz. Eaſt, Weſt, North, and South.

XXXIV. EQUINOCTIAL POINTS. Theſe are the Points, where the Equinoctial and Ecliptic interſect each other, in oppoſite Sides of the Globe; (or diametrically) the Firſt, or the Beginning of Aries, is called the *Vernal Equinox*, becauſe when the Sun arrives here, it is the Beginning of Spring. The Second in the Beginning of Libra, called the *Autumnal Equinox*, becauſe, when the Sun arrives there, it is the Beginning of Autumn.

XXXV. REFRACTION, in ASTRONOMY, is the difference between the true and apparent Altitudes of an Object; and is wholly occaſioned by the Atmoſphere, making the heavenly Bodies appear higher, or more elevated, than they really are. This was wonderfully manifeſted by ſeveral Hollanders, who had wintered in the Iſland of Nova Zembla, in 1596, where they had a full View of the Sun, when his true Place was Four Degrees below the Horizon. It is of the utmoſt uſe to Navigators, in the Night, by cauſing Mountains, Rocks, &c. to appear above their natural Height; hence they have an Opportunity of ſhunning many Dangers that might otherwiſe befal them; which is a wonderful Mark of Divine Providence.

XXXVI. TWILIGHT. This is a Medium between *Light* and *Shade*, and happens every Morning and Evening. When the Sun approaches within 18 Degrees of the Horizon, in the Morning, Twilight begins; and when he is depreſſed 18 Degrees below the Horizon, in the Evening, Twilight ends.

XXXVII. CREPUSCULUM. This is an imaginary Circle, parallel to the Horizon, at the Diſtance of 18 Degrees below it; where the Beginning and Ending of Twilight takes place.

XXXVIII. ATMOSPHERE. This is a Maſs of Air, which ſurrounds the Earth, and of which it is a conſtant Companion; the Height of the Atmoſphere has never yet been aſcertained, nor is it probable that it ever will; however, it it ſo rare above the Height of 45 or 46 Miles, that it cannot reflect the Sun-beams to the Eye. It is to the Atmoſphere that we owe the Benefit of *Twilight*, as well as our *Health*, our *Strength*, and Spring of *Motion*; the Conveyance of *Sounds* entirely depend upon it: the feathered *Tribes* owe their Exiſtence to this Source, and the whole Syſtem of Vegetation is nouriſhed thereby.

Of the Positions of the SPHERE.

A SPHERE can have but three Poſitions, viz. Right, Oblique, and Parallel.

I. Of a RIGHT SPHERE.

A RIGHT SPHERE has its Poles in the Horizon; hence the Equator will paſs through the Zenith and Nadir Points.

The Places which have a Right Sphere, are thoſe on the Equator; every Point of the Heavens will ſeem to move perpendicularly above the Horizon, and will deſcribe Circles parallel to the Equator, in its diurnal Motion. Thoſe Stars which riſe together, will come to the Meridian together, and will likewiſe ſet together; this is plain to any One who has practiſed on the Globes; and even to thoſe who have not known the Uſe of the Globes, by barely reaſoning upon it.

II. Of an OBLIQUE SPHERE.

An Oblique Sphere, is when the Horizon cuts the Equator at oblique Angles, one Pole being above it, and the other below it; the one always being viſible, the other always inviſible. The Equator is half above the Horizon, and half below it, as in the Right Sphere, but the Days and Nights are never equal, but when the Sun is in the Equinoctial, as he is paſſing from North to South, and the contrary, in March and September; ſo that all the Inhabitants of the Earth, except under the Equator and the Poles, have the Globe in an oblique Poſition, and is more or leſs oblique, as the Pole is more or leſs elevated.

III. OF A PARALLEL SPHERE.

In a Parallel Sphere, the Equator coincides with the Horizon, and the Pole of the World with the Zenith: the Poſition of this Sphere, agrees with none but the Inhabitants of the Poles of the Earth. Celeſtial Bodies deſcribing Circles parallel to the Equator, will alſo deſcribe them parallel to the Horizon; conſequently, a fixed Star in either Hemiſphere, can never ſet to its reſpective Pole. Hence it is, that the Sun being ſix Months on either Side of the Equator, thoſe Polarians (if any there be) muſt have ſix Months Day, and ſix Months Night, alternately.

Note. On theſe Poſitions of the Sphere, the different Projections uſed in Maps are grounded.

The SITUATION of PLACES and INHABITANTS of the EARTH, with reſpect to their PARALLELS, MERIDIANS, and SHADOWS.

PLACES are generally put in Oppoſition three different Ways, by reaſon of the Terreſtrial Circles, whence they may be diſtinguiſhed into three Sorts.

I. Thoſe Places, which by their Situation, are on oppoſite Meridians, and ſame Parallel of *Latitude*, having the ſame Altitude of the Pole, but the difference of Longitude 180 Degrees, are termed *Periœci.* The Days and Nights are equal, as well as the Seaſons of the Year; only, that when it is Day with One, is Night with the Other, and vice verſa. Places under the Pole have no Periœci.

II. Places ſituated on the ſame Meridian, but on oppoſite Parallels, ſo as to have the ſame Latitude and Longitude, but on contrary Sides of the Equator, are *Antiœci* to each other; their Seaſons of the Year are contrary, and the Days of the one, are equal to the Nights of the other, though the Hours of the Day and Night are the ſame; that is, when it is ſix o'Clock in the Morning, with the one, it is ſix o'Clock with the other alſo.

III. Places on oppoſite Meridians, and oppoſite Parallels, as well as on oppoſite Points of thoſe Parallels, differing 180 Degrees in Longitude, but have the ſame Degrees of Latitude, though on contrary Sides of the Equator, are termed *Antipodes* to each other, being diametrically oppoſite. The Seaſons of the Year to thoſe Places are contrary, as well as the Days and Nights; for when it is Summer with the one, it is Winter with the other; and when it is Day with the one, it is Night with the other, &c.

Note. What is here ſaid of Places, may be applied to the Inhabitants.

The INHABITANTS of the EARTH, in reſpect to their SHADOWS, are diſtinguiſhed into *Amphiſcii*, *Aſcii*, *Heteroſcii*, and *Periſcii*.

I. OF THE AMPHISCII.

THESE are the Inhabitants of the Torrid Zone, and are ſo called becauſe their Noon Shadow is caſt different Ways, according as the Sun is Northward or Southward of their Zenith. When the Latitude and Declination are the ſame, thoſe Inhabitants, where the Sun is vertical, will have no Shadow at Noon; hence they are termed *Aſcii*.

II. OF THE HETEROSCII.

Theſe are the Inhabitants of the Temperate Zone; and are ſo called, becauſe their Noon-Shadow will always fall one Way, according to the Zone they inhabit; that is, thoſe in the North Temperate Zone, will have their Noon-Shadow caſt due North; and thoſe who inhabit the South Temperate Zone, will have their Meridian Shadow caſt due South.

Note. Thoſe Inhabitants of the Earth whoſe lot it is to dwell under either of the Tropics, will become *Aſcii* once every Year, *i. e.* when the Sun arrives at thoſe Tropics reſpectively.

III. OF THE PERISCII.

Theſe are the wretched People (if any) who inhabit the Polar Regions, and have their Shadows (when the Sun is in their Hemiſphere) turned quite round every 24 Hours.

PART II.

CONTAINING,

A COMPENDIOUS SYSTEM of the GEOGRAPHY of the TERRAQUEOUS GLOBE.

THE Surface of the TERRAQUEOUS, or TERRESTRIAL GLOBE, is *naturally* and *politically* divided.

I. The SURFACE of the EARTH, is naturally divided into Land and Water, as when it received its *Form*, and when GOD ſaid, "Let the Waters under the Heavens be gathered together unto one Place, and let the dry Land appear."

II. The SURFACE of the EARTH is *politically* divided; the Land into Empires, Kingdoms, States, &c. The Water into Oceans, Seas, Lakes, Rivers, &c. by the Artifice of Man, for the benefit of Trade and Commerce; each of which Diviſions ſhall be explained or deſcribed, as follows: and firſt, of the Natural Diviſions.

OF THE LAND.

I. A CONTINENT, is a large Quantity of Land, in which are many Countries, without being ſeparated by Seas. Such are the Continents of Europe, Aſia, Africa, and America, which four are called the Four Quarters of the World, or its principal Diviſions.

II. PE-

II. A PENINSULA, is a Part of Land, almoſt ſurrounded by water ſuch is the Morea in Greece; Gibraltar, in Spain; even Africa itſelf is a Peninſula.

III. An ISTHMUS, is a narrow Neck of Land, joining a Peninſula, as the Neck doth the Head to a Body; and ſuch is the Iſthmus of Suez, which joins Africa to Aſia; the Iſthmus of Darian, which joins North and South America.

IV. A PROMONTORY is a Part of Land, which ſtretches a great way into the Sea, and is ſometimes called a Cape, Head-land, or Point; ſuch is Cape Horn, the Cape of Good Hope, Land's-End, in England, &c.

V. An ISLAND, is a Portion of Land, entirely ſurrounded by Water, as Great Britain, Ireland, New Holland, &c.

VI. A SHORE is that part of Land which borders on the Sea, whether Iſland or Continent.

OF THE WATER.

I. An OCEAN, is a large Collection of Water, not divided, or interſected by Land. Such are the Atlantic, the Pacific, and Ethiopic Oceans.

II. A SEA is a part of Water almoſt ſurrounded with Land, except one narrow Space or Neck, as the Red Sea, the Mediterranean Sea, the Euxine, or Black-Sea, the Baltic. &c.

III. A STRAIT is a narrow Space or Neck of Water, joining one Sea to another, or of a Sea to an Ocean, as the Straits of Gibralter, Straits of Babalmendal, the Straits of Sunda, Malacca, &c,

A LAKE is a Quantity of Water, entirely ſurrounded by Land, as Aral and Baikal in Great Tartary, the Dambea, in Abyſſinia, Ladoga and Onega in Ruſſia; and indeed the Caſpian Sea, though it receives the Water of ſo many large Rivers, cannot properly be called any thing elſe than a Lake.

V. A BAY or GULF, is a Part of the Sea which runs a great way into the Land, ſo as to be three parts in four ſurrounded by it: ſuch is the Gulf or Bay of Mexico, Gulf of Venice, Bay of Biſcay &c.

VI. A RIVER is a Stream of freſh Water, riſing from one or more Springs, and running through ſeveral Countries, falls at length into ſome Lake, Sea, or Ocean; ſuch is the Wolga, the Danube, the Ganges, &c.

Secondly, The Terraqueous Globe is politically divided, as was ſaid before, into Empires, Kingdoms, States, &c. for the Benefit of Trade and Commerce. And firſt, of the Land, which is divided into four large Continents, &c Europe, Aſia, Africa and America; with the Addition of South India, and the Arctic and Antarctic Lands, with ſome other Places of later diſcovery.

OF EUROPE IN GENERAL.

EUROPE, which is by far the moſt populous of the four Quarters, is bounded on the North, by the North Sea; on the Eaſt by Aſia; on the Weſt by the Atlantic Ocean; and on the South by the Mediterranean Sea, which ſeparates it from Africa. It is in Length about 3000, and in breadth about 2500 Miles; being comprehended between 35 and 72 Degrees of North Latitude, and between 10 degrees of Weſt, and 60 Degrees of Eaſt Longitude.

The Air is Temperate, the Soil is in general fertile; it is mighty in Trade, abounds with all manner of Riches, and excellent in all the Arts and Sciences. The profeſſed Religion is Chriſtianity.

As Europe is divided, it contains thoſe Empires, Kingdoms, &c. mentioned in the following Table, with the principal Iſlands, Seas, Gulfs, Bays, Rivers, &c. annexed; the Poſition of each Kingdom, in regard to the Middle of the Continent; the Diſtance of the Capital of each Country from London, in Britiſh Statute Miles, and the Length of the longeſt Day, at each; as exhibited on Meſſrs. Palmer and Newton's 15 Inch Globes; being the ſize uſed in my School.

The TABLE.

Countries	Poſition	Cap. Cities	Diſ. fr. Lon	Longeſt D
				H. : M.
France	W.	Paris	226	15 : 55
Spain	S. W.	Madrid	799	14 : 52
Portugal	S. W.	Liſbon	990	14 : 46
Italy	S.	Rome	904	15 : 00
Sardinia	S.	Turin	650	15 : 20
Sicilies	S.	Naples	1009	14 : 55
Switzerland	Mid.	Bern	452	15 : 34
U. Provinces	W.	Amſterdam	180	16 : 34
Germany	Mid.	Vienna	730	15 : 45
Bohemia	Mid.	Prague	640	16 : 2
Hungary	E.	Buda	904	15 : 36
Poland	Mid.	Warſaw	869	16 : 30
Pruſſia	N. W.	Berlin	590	16 : 32
Sweden	N.	Stockholm	860	18 : 15
Denmark	N. W.	Copenhagen	556	17 : 7
Norway	N. W.	Bergen	642	18 : 36
Ruſſia	N. E.	Peterſburgh	1320	18 : 30
Turkey in Europe	S. E.	Conſtantinople.	1529	14 : 53
England	W.	London		16 : 26
Scotland	W.	Edinburgh	318	17 : 12
Ireland	W.	Dublin	330	16 : 45

To EUROPE belong the following Iſlands, &c.

In the Weſtern and Northern Ocean are Great Britain, Ireland, Orkneys, Shetland, Hebrides, Iceland, Weſt Greenland, &c.

In the Mediterranean Sea, are Ivica, Majorca, Minorca, Sardinia, Corſica, Sicily, Candia, Leucadia, Malta, and ſeveral ſmaller Iſlands of leſs Note, in the Archipelago, which were celebrated in the Songs of Ancient Greece.

In the Engliſh Channel are Jerſey, Guernſey. Alderney, Sark, and Wight, Iſlands.

In the Baltic are likewiſe ſeveral Iſlands, the principal of which are, Zealand, Femen, Bornholm, Oeland, Gothland, Aland, Drago, Oſel, &c.

The principal Seas, Gulfs, Bays, Straits, and Rivers, in Europe.

THE Mediterranean Sea, having Europe on the North, and Africa on the South.

The Adriatic, between Italy and Turky,

The Euxine, or Black Sea, between Europe and Turky.

The German Sea, between Germany and England.

The Sea of Aſoph, between Europe and Aſia.

The White Sea, N. N. W. of Ruſſia.

The Baltic Sea, between Denmark, Sweden, Poland, &c.

The Engliſh Channel, between England and France.

The Iriſh Sea, or St. George's Channel, between England and Ireland.

The Bay of Biſcay, formed between France and Spain.

The Gulf of Venice in the Adriatic.

The Gulf of Finland, between Ruſſia and Sweden.

The Gulf of Bothnia, in the N. E. Parts of Sweden.

The Straits of Gibraltar, between the Mediterranean and Atlantic.

The

The principal RIVERS.

THE THAMES, in England, which riſes in Glouceſterſhire, and paſſing Oxford, Abingdon, Reading, Maidenhead, Windſor, Kingſton, Richmond and London, falls into the German Sea, at Graveſend.

The Severn, in England, riſes in Montgomeryſhire, and falls into the Atlantic Ocean below Briſtol.

The Trent, in England, riſes in Staffordſhire, and falls into the German Sea, below Kingſton-upon-Hull.

The Forth, in Scotland, riſes in Montieth, and forming the Frith of Forth, falls into the German Sea.

The Shannon, in Ireland, riſes in Lietrim, and falls into the Atlantic; after a long Courſe through the Counties of Leinſter, Connought, and Munſter.

The Dwina, riſes in the Eaſt of Ruſſia, and falls into the White Sea, at Archangel.

The Wolga riſes about the Middle of Ruſſia, and after a long Courſe empties itſelf into the Caſpian Sea.

The Don riſes alſo in Ruſſia, and empties itſelf into the Black Sea.

The Danube riſes in Swabia, and paſſing thro' Vienna, Preſburg, Buda and part of Turky falls into the Black Sea.

The Rhine, riſes in Switzerland, taking in its way, the Lake of Geneva, Lions, &c. and falls into the Mediterranean.

The Weiſel, riſes ſouth of Sileſia, and paſſing thro' Cracow and Warſaw, falls into the Baltic Sea.

The Rhone riſes in Switzerland, taking in its Way the Lake of Geneva, Lions, &c. and falls into the Mediterranean.

The Seine riſes in Burgundy, and waſhing Paris falls into the Engliſh Channel.

The Tagus riſes on the Confines of Arragon, and ſhaping its Courſe Weſt, waſhes the Walls of Toledo and Liſbon, near the latter of which it falls into the Atlantic.

The Tiber (famed of old) riſes in the Appennines, and paſſing thro' Rome, diſpoſes of his Stream in the Mediterranean.

The Po (equally famous with the Tiber) riſes in Piedmont, and paſſing by Turin, in its Courſe eaſtward, falls into the Gulf of Venice.

OF ASIA IN GENERAL.

ASIA is bounded on the North by the main Sythic, or Frozen Ocean; on the Weſt by Europe, and the Red Sea; on the Eaſt by the great Pacific Ocean, or South Sea, which divides it from America; and on the South by the Indian Ocean.

This Quarter of the Globe is comprehended between the Equator and eighty Degrees of North Latitude, and between 25 and 180 Degrees of Eaſt Longitude,

the

the Continent being about 5213 ſtatute Miles, in Length, from North to South; and about 5552 in Breadth, from Eaſt to Weſt. It is renowned as being the Place where Man was firſt created; for the Garden of Eden; the Riſe and Fall of the greateſt and mightieſt Monarchs. It was honoured by the Birth of our bleſſed Lord and Saviour, by the many Miracles he wrought among the Unbelieving, and by the glorious Redemption of the World. The Natives are of a ſwarthy Complexion, and for the moſt part, Pagans and Mahometans.

The principal Diviſions of Aſia, will be ſeen in the following Table, with the Poſition of each Part, in regard to the Middle, the Capital of each, with its Diſtance from London, and Longeſt Day.

THE TABLE.

Kingdoms & States.	Poſition.	Ch. Cities & Towns.	Diſtance fr. Lond.	Longeſt Day.
				H. M.
Turkey in Aſia, including the Leſſer Aſia.	W. and S. W.	Burſa	1598	14 : 48
		Smirna	1633	14 : 30
		Aleppo	2120	14 : 25
		Damaſcus	2241	14 : 4
		Jeruſalem	2274	14 : 0
Arabia.	S. W.	Mecca	2988	13 : 15
		Medina	2720	13 : 30
		Mocha	3614	12 : 38
Perſia with part of Circaſſia, Mingrelia & Uſbeck Tartary.	S. S. W.	Iſpahan	2815	14 : 4
		Schiras.	3058	13 : 50
		Gombaroon	3267	13 : 41
		Samarkand.	3186	14 : 45
India, weſt of the Ganges & Golconda	S.	Delhi	4294	13 : 39
		Agra	4366	13 : 34
		Lahor	3944	14 : 4
		Golconda.	4846	12 : 53
India, eaſt of the Ganges comprehending Ava, Arracan, Pegu, Siam, Laos, Malacca, Cambodia Tonguin, Cochin—China &c	S. S. E.	Ava	5352	13 : 15
		Arracan	5250	13 : 13
		Pegu	5590	13 : 0
		Siam	5900	12 : 48
		Malacca	6533	12 : 6
		Cuabang	5768	13 : 4
		Cambodia	6146	12 : 38
		Keceio	5649	13 : 15
		Quinin.	6346	12 : 41
China, including Korea.	S. E.	Pekin	5000	14 : 54
		Nankin	5590	14 : 0
		Canton	5875	13 : 25

The TABLE continued.

Kingdoms & States.	Poſition.	Ch. Cities & Towns	Diſtance fr. Lond.	Longe Day.
				H. M
Chineſe Tartary	E.	Ruing	4865	15 : 4
Thibet & Mogul Tartary	Mid.	Pontala	4796	13 : 58
Siberia comprehending all the North of Aſiatic Tartary	N. E,	Tobolſkoi	2433	17 : 54
	and			
& Aſtracan.	N.	Aſtracan	2433	15 : 40
Calmuc Tartary.	N. W.	No particular Place		

The Iſlands belonging to Aſia, are thoſe in the Levant and Archipelago, in poſſeſſion of the Turks, and thoſe called the Oriental Iſlands in the Indian Ocean; of which thoſe of Japan, Sumatra, Java, Formoſa, Borneo, Aynian, the Philippines, Celebes, Macaſſar, Gilolo, Ceram, Moluccas, Banda, Ceylon, Flores, and Timor, are the principal.

SEAS, &c. in ASIA.

The Eaſtern Ocean, or great South Sea.

The Caſpian Sea, on the North of Perſia.

The Icy Sea, within the Arctic Circle.

The Sea of Len, N. E. of Tartary.

The Eaſtern Sea, between Tartary, Yedſo, and the Japan Iſles.

The Bay or Sea of Bengal, between the Eaſt and Weſt parts of India.

The Arabic Sea, between Arabia and India.

The Indian Sea, on the South of the Arabian Sea.

The Gulf of Perſia, between Perſia and Arabia.

The Gulf of Siam, between Malacca and Cambodia.

The Gulf of Cochin China.

The Straits of Malacca, Sunda, Macaſſar, &c.

Principal RIVERS in ASIA.

THE Oby and Jeniſſa, which riſe in Calmuc Tartary, and diſpoſe of their Floods in the Northern Ocean.

The Euphrates, which riſes near Erzerum, divides Turcomania from Natolia, Diarbec from Syria and Arabia, paſſing through Eyraca Arabic, by Baſſora, and empties itſelf into the Perſian Gulf.

The Tigris, which riſes in Turcomania, ſeparates Diarbec from Curdiſtan, and waſhing the Walls of Bagdat, joins its Waves, with the Euphrates, in Eyraca Arabic.

The Ganges, which riſes in Thibet, and paſſing through Indoſtan, diſcharges itſelf into the Bay of Bengal.

The Indus, which riſes in the Mountains on the Confines of Great Tartary, and falls into the Gulf of Scindi.

The Grocei, which riſes in the Purbet Mountains, on the South Weſt of Thibet, paſſing through that Country, enters China, and after croſſing that extenſive Empire, falls into the Bay of Nankin.

Of AFRICA in general.

THIS extenſive Peninſula is bounded on the Eaſt, by the Red Sea, or Gulf of Arabia, and the Iſthmus of Suez; on the Weſt, by the Atlantic Ocean, which ſeparates it from America; on the North, by the Mediterranean, which ſeparates it from Europe; and on the South, by the Southern Ocean.

This Quarter of the Globe is ſituate moſtly in the Torrid Zone; and is comprehended between 34 Degrees of South and 37 Degrees of North Latitude; and between 17° 20′ Weſt, and 51° 20′ of Eaſt Longitude; being 5000 Miles in Length, and about 3991 in Breadth.

The principal Places in Africa are exhibited in the following Table, with their Diſtance from London, and the longeſt Day at each, as appears by the *Terreſtrial Globe* before mentioned.

The interior Parts of Africa are leſs known than any other Part of the Globe; the Natives being, in general, of an indolent and ſavage Diſpoſition: hence all Attempts to reclaim them have hitherto proved abortive. The prevailing Religion is that of the famous Impoſtor Mahomet, in whoſe Tenets they are enthuſiaſtic.

The TABLE.

	Nations.	Chief Cities.	Diſt. from London.	Longeſt Day.
				H. M.
Barbary.	Morocco	Fez	1294	14 : 4
	Algiers	Algiers	1040	14 : 30
	Tunis	Tunis	1112	14 : 30
	Tripoli	Tripoli	1460	14 : 8
	Barca.	Albion	2016	13 : 55
	Egypt	Grand Cairo	2209	13 : 48
	Biledulgered	Dara	1702	13 : 45
	Zaara	Sanhaga	2085	13 : 26
	Negroland	Tombut	2636	12 : 53
	Guinea	Benin	3026	12 : 26
Up Ethiopia	Nubia	Nubia	2884	13 : 5
	Abyſſinia	Gonder	2304	12 : 45
	Abex.	Doncala	3127	13 : 00
Low Guinea	Loango	Loango	3759	12 : 15
	Congo	St. Salvador	3924	12 : 20
	Angola	Loando	4170	12 : 30
	Benguela	Benguela	4394	12 : 45
	Matanan			
	Anian	Magadoxo	4205	12 : 10
	Zanguebar	Melinde or	4399	12 : 15
		Moſambique	5249	12 : 54
	Monomotapa	Monomotapa	5491	13 : 46
	Monemugi	Sena	5086	13 : 4
	Sofola	Sofola	5447	13 : 12
	Terade nation			
	Caffaria, or Hottentots	Cape of Good Hope	6047	14 : 15

Prin-

Principal ISLANDS in Africa.

BABELMANDAL, Zocotra, Comora Iſles, Madagaſcar, Mauritius, Bourbon, St. Helena, Aſcenſion, St. Matthew, St. Thomas, Princes Iſle, Cape Verde Iſlands, Goree, Madeira, Canary Iſlands, and the Azores; the latter of which are ſometimes reckoned among the European Iſlands.

The principal SEAS, GULF, BAYS, &c.

THE Red Sea, between Africa and Aſia.

The Mediterranean Sea, between Africa and Europe.

The Channel of Mozambique.
The Bight of Benin.
The Straits of Babelmandal.
The Straits of Gibraltar.
The Gulf of Sofalia.

The principal RIVERS in Africa.

THE Nile, which riſes in the Middle of Abyſſinia, paſſes through a Part of Nubia; when entering Egypt, it is joined by the double Stream of the Rivers Nubia and Sira; becoming thus formidable, by tributary Streams, enters the Mediterranean, in ſeveral Branches. At a certain Seaſon of the Year, the Nile deluges a great Part of Lower Egypt.

The Niger, or Senegal. This River takes its Riſe at Lake Niger, in Ethiopia, paſſes through a Part of the Deſart, and after running the whole Length of Negroland, diſcharges itſelf into the Atlantic.

The Gambia is a Branch of the Niger.

Cuma. This River riſes on the Borders of Monomotapa and paſſing through the Middle of Monemugi, diſcharges itſelf into the Channel of Mozambique.

OF AMERICA IN GENERAL.

THIS Continent is divided into two large Peninſulas, the northermoſt is called Mexicana, or North America, and the ſouthermoſt Peruana or South America.

The former is divided into ſeveral Provinces, which, till the late unhappy Rebellion, did Homage to Great Britain's Monarch; having been diſcovered at the Charge of Henry VII in 1497.

The ſecond Peninſula contains ſeveral Provinces, belonging to the Kingdoms of Spain and Portugal, and was diſcovered by Columbus, in 1491 at the Charge of the Spaniſh Monarch Ferdinand, or rather of his Queen Iſabella.

This large weſtern Continent, extends from 80 Degrees of North, to 57 Degrees of South Latitude, and between 35 and 136 Degrees of Weſt Longitude, from the Meridian of London. It is bounded on the Eaſt, by the Atlantic Ocean; on the Weſt by the Pacific Ocean; by Frozen Regions on the North; and on the South by the Great South Sea..

The Iſthmus of Darien, by which thoſe two Peninſulas are joined is near 500 Miles in length, and ſo narrow near Panama, as not to exceed 60 Miles,

GRAND DIVISIONS of SOUTH AMERICA.

Countries	Leng	Bread	Chief Cities	Belong	Diſt. fr. Lon.
Terra Firma	1400	700	Panama	Spain	5421
Peru	1800	1500	Lima	Ditto.	6325
Paraquay	1500	1000	Buenos Ayres	Do. & Jeſuits	7089
Chili	1200	500	St. Jago	Spain	7262
TerraMagellanica or Patagonia	700	300		Its Natives	
Brazil	2500	700	St Sebaſtian	Portug	5808
Amazons	1200	960		ItsNat.	
Guiana	780	480	Surinam & Cayenne.	Dutch French	4518 4448

Or

Of the GRAND DIVISIONS of NORTH AMERICA, together with the Length, Breadth, Chief Towns in each; the Kingdoms to which they belong, and the exact Diſtance of each Capital from LONDON, in Britiſh Statute Miles.

Countries and Colonies.	Length	Breadt	Ch. Cities	Belong to	Diſtance from London
Old Mexico	2000	600	Mexico	Spain	5770
N. Mexico and California	2000	1600	St. Fee	Ditto	5074
Louſiana			New Orleans	Ditto.	
E. & W. Florida	500	440	St Auguſtine & Penſacola	France and Spain.	4343 4621
N. & S. Carolina and Georgia	700	380	Ch Town Savannah	United States.	3371 4170
Virginia	750	240	James's Town.	Ditto.	3750
Maryland	140	135	Anapolis	Ditto.	3614
Penſylvania	300	240	Philadelphia.	Ditto.	3510
The Jerſeys.	160	60	Perth Amboy	Ditto.	3475
New York	300	150	N. York	Ditto.	3451
N. England	550	200	Boſton	Ditto.	3267
Nova Scotia	350	250	Halifax.	Great Britain	2989
Canada	800	200	Quebec	Ditto.	3266

To AMERICA belong the following principal Iſlands, viz.

LONG-Iſland, Staten-Iſland, Rhode-Iſland, Cuba, Porto Rico, Virgin-Iſlands, Trinadada, Chiloe, Guadaloupe, St. Lacia, St. Bartholomew, Diſeada, Marigalante, St. Euſtatius, Curaſou, St. Thomas, Santa Cruz, Jamaica, Barbadoes, St. Chriſtopher's, Antigua, Barbuda, Anguilla, Dominica, St. Vincent, Grenada, Tobago, Newfoundland, Cape Breton, St. John's, Bermudus, Bahammas, Falkland Iſlands, and the Iſland of Delfugo.

Principal SEAS, BAYS, STRAITS, &c.

THE Caribbean, or North Sea.

The Red Sea, or the Gulf of California.

The Bay, or Gulf of Mexico.

The Gulf of Florida

The Bay of Fundy.

The Bay of Panama.

Gulf of Campeachy,

The Bay of Honduras.

The Gulf of St. Lawrence

Baffin's Bay.

Hudſon's Bay.

Hudſon's Straits.

Straits of Magellan.

Straits La Maire.

The principal Rivers in AMERICA.

ST. LAURENCE; which riſes in Lake Illenois, paſſing thro' Huron Lake, Erie Lake, and Lake Ontario, waſhing Montreal and Quebec, falls into the Bay of St. Laurence.

Miſſiſſippi (now St. Louis) riſes in Sioux Lake, to the Weſt of New South Wales, and after receiving into its Boſom a great number of Rivers, parts with its Flood in the Gulf of Mexico.

North River, which riſes in New Mexico, and falls into the Gulf of Mexico.

Blue, and Colorado Rivers, riſe in the unknown Parts of New Albion, and fall into the Vermilion Sea, or Gulf of California.

River Grande, which riſes near St. Fee, in Terra Firma, and falls into the Caribbean or North Sea.

River Oronoque, which riſes on the Borders of Peru, paſſes a conſiderable Way on the Borders of Amazonia, then ſhaping its Courſe due North, falls into the Atlantic Ocean.

Amazons; which riſes almoſt on the weſtern Coaſt of Peru, and taking a winding Courſe of ſome thouſands of Miles, falls into the Atlantic Ocean, near the Equator.

Rio de la Plata; which riſes in Lake Xarayes, in Paraguay, and after running the whole Length of that Country, falls into the Southern Ocean, below Buenos Ayres.

OF SOUTH INDIA.

UNDER this Title is comprehended thoſe ſeveral Iſlands, which were unknown to the Ancients; but have been diſcovered by different European Navigators; and foremoſt in that Liſt ſtands our own Countryman, Capt. James Cook, who was ſhamefully murdered by the Natives of Owyhee, in his third Voyage Round the World, in February 1779, whoſe Death muſt be a real Loſs to Europe.

The principal of thoſe Iſlands in the Southern Ocean, is New Holland, comprehended between 10 and 44 Deg. of South Latitude and 110½ Deg. and 153½ Deg. of Eaſt Longitude; the moſt ſoutherly Point of which, was diſcovered by Captain Taſman, in 1642; and as ſuch it appears in all the old Maps of the World. The northern Point was diſcovered by ſome Hollanders, in 1644, to which they gave the Name of New Holland; however, none of thoſe Voyagers who touched upon it, were able to determine its Bounds; this Work remained to be executed by the above-named Mariner, and who, in the Year 1770, made a full diſcovery of the ſame, coaſting the ('till then) unknown Side, from North to South, near 2000 Miles, and took poſſeſſion of it, as an Iſland, in the Name of his Britannic Majeſty, calling it New South Wales.

Botany-Bay, which at preſent engroſſes ſo much of the public Attention, is ſituate in 34 Degrees 20 Minutes of South Latitude, and in 150 Degrees Eaſt Longitude, from the Meridian of London; conſequently, in a very temperate Climate.

New Zealand; two large Iſlands to the South Eaſt of New Holland; firſt touched upon by Capt. Taſman, in 1642, and compleatly diſcovered by Capt. Cook, in 1769, who made an accurate ſurvey of its Coaſts, and took Poſſeſſion of it, in the Name of his Majeſty King GEORGE the Third.

Otaheite; diſcovered by Capt. Wallis, and called by him King GEORGE the Third's Iſland, on the 19th of June, 1767. This Iſland is ſituate within the 18th Degree of South Latitude, and 149th Degree of Weſt Longitude. It was afterwards viſited by Capt. Cook, Joſeph Banks, Eſq. and Dr. Solander, in order to obſerve the Tranſit of Venus over the Sun's Diſk; by which the heavenly Science of Aſtronomy, has received conſiderable Improvement.

Beſides the Iſlands above deſcribed, there are many others, a Deſcription of which would be too tedious for the preſent Purpoſe; I will therefore refer my Readers to Books wrote wholly on the Subject, of which the Public are (or may be) plentifully ſerved.

TERRA ARCTICA, or ARCTIC LAND.

THIS is a ſuppoſed Continent, ſurrounding the North Pole, and is likewiſe called Incognito, or

Unknown Land; all Attempts to diſcover it, proving hitherto unſucceſsful, from the ſevere Froſt, and great quantity of Ice, that eternally ſurrounds this inhoſpitable Region; and which has proved fatal to ſeveral brave Europeans; Witneſs, Sir Hugh Willoughby, and his Ship's Crew, in Queen Elizabeth's Reign

——————— "Miſerable they!
"Who here entangled in the gathering Ice,
"Take their laſt Look of the deſcending Sun;
"While, full of Death, and fierce with tenfold Froſt,
"The long long Night, incumbent o'er their Heads,
"Falls horrible."———————

THOMPSON.

TERRA ANTARCTICA, or ANTARCTIC LAND.

THIS is a ſuppoſed Continent, ſurrounding the ſouth Pole of the Globe, and is likewiſe termed Incognito, or unknown. Its great Diſtance from Europe, and the Reaſons given in Terra Arctica, as hath been fully proved by Captain Cook, in the Endeavour, forbids its being further explored.

PART

PART III.

CONTAINING

Fifty-two PROBLEMS, on the TERRESTRIAL GLOBE, with their SOLUTIONS.

PBOBLEM I.

TO rectify the Globe to the Latitude of any particular Place.

RULE.

Elevate the North Pole of the Globe (if in North Latitude) till the given Degree and Minute appear above the Horizon, under the ſaid Pole; bring the given Place to the eaſtern Side of the Brazen Meridian, and let the Quadrant of Altitude be ſcrewed exactly over the ſame; lay the Quadrant to the eaſtern Point of the Horizon (placing the Globe due North and South, by means of a Compaſs) ſo will the Globe be rectified.

Thus for London, which is in 51° 32′ North Lat. I raiſe the North Pole till 51° 52′ appear above the Horizon, and act according to the Rule, whence the the wooden Horizon will be the true Horizon of that Place; the Pole of the Globe will point to the Pole in the Heaven, and the Equator to the Equinoctial, &c. &c. as repreſented in the Frontiſpiece.

PROBLEM II.

To find the Latitude and Longitude of a Place.

RULE.

Bring the given Place to the Brazen Meridian, and obſerve how many Degrees are contained between the given Place, and the Equator; which will be the Latitude required; and the Degrees counted on the Equator, either Eaſtward or Weſtward, from the firſt Meridian, to the Edge of the Brazen Meridian, will be the Longitude required.

Thus, by obſerving the above Rule, London will be found in Latitude 51° 32′ North of the Equator, but on account of the firſt Meridian, paſſing through that Place, it can have no Longitude, it being from thence that Longitude is reckoned. But Rome, which will be found in 41° 50′ North, has 13 Degrees of eaſtern Longitude; Dublin in 53° 15′ North Latitude, and 6° 25′ of Weſt Longitude; and ſo of any other Place.

PROBLEM III.

The Longitude and Latitude of any particular Place being given, to find the ſame upon the Globe.

RULE.

Find the Longitude on the Equator, and bring the ſame to the eaſtern Side of the Brazen Meridian (ſtaying the Body of the Globe, by thruſting a Quill under the Meridian) then reckon North or South from the Equator, according as the Latitude is North or South, and directly under the given Degree, is the Place required.

Example I. Let it be required to tell what particular Place has 60 Degrees of Weſtern Longitude, and 13 Degrees of North Latitude. By the above Directions the required Place is Barbadoes, an Iſland in the Weſt Indies.

Example. II. There is a particular Place upon the Globe, in Longitude 20° 7′ Weſt of the Meridian of London, and has 34° 15′ of South Latitude; required that Place. Anſwer, The Cape of Good Hope, in Africa.

Example III. What Place upon the Globe has 19 Degrees of North Latitude, and 155 Degrees of Weſt Longitude? By the Rule, the required Place is Owhyhee *, in the Great Pacific Ocean. [illegible]

PROBLEM IV.

The Latitude of a Place being given, to find what other Place has the ſame Latitude.

RULE.

Bring the given Place to the Brazen Meridian, and make a Mark over the ſame, then turn the Globe gently round upon its Axis, obſerving what Places paſs under the ſaid Mark; for they have all the ſame Latitude, with the given Place.

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* It will be neceſſary to remark here, that this Iſland is variouſly placed by Geographers, and it is greatly to their Diſhonour, that this, and ſeveral ſuch-like Errors paſs uncorrected upon our Maps and Globes. Upon my Globes, made by Meſſrs. Palmer and Newton, it is placed as above; but in the Map of the World, which accompanies Millar's Geography, it is placed in 23 Degrees of North Latitude, and 160 Degrees of Weſt Longitude from London.

Example. Required all thoſe Places upon the Globe, which have the ſame Latitude with Conſtantinople, whoſe Latitude is 41 Degrees North. Anſwer. Amaſia, in Armenia; Gangea, in Georgia; Alchach, in Tartary; Karakaton, in China; the Falls of Niagara, in Canada; Nantucket Iſland; Oporto, in Portugal; and Naples, in Italy.

14 [illegible]

PROBLEM V.

The Longitude of a Place being given, to find what other Places on the Globe have the ſame Hours of the Day and Night, with the given Place; conſequently the ſame Longitude.

RULE.

Bring the given Place to the Meridian, and ſtay the Globe; obſerve what Places lie under the eaſtern Side of the Brazen Meridian, for thoſe are the Places required.

Example. Suppoſe that all Places in the ſame Longitude with Rome, were required. I bring Rome, as directed to the Brazen Meridian, and all thoſe Places which lie even with the Edge of the ſame is the Anſwer.

PROBLEM VI.

To find the Difference of Latitude between any two Places on the Globe.

Note. In this Problem there are two Varieties, viz. Firſt, When the Latitudes are both North, or both

South. Secondly, When they are on different Sides of the Equator, or one North, and the other South. To perform either of which, obſerve the following eaſy

RULE.

If the Latitudes be both North, or both South, ſubtract the leſſer Latitude from the greater, and the difference will be the Anſwer. But if the one be North and the other South, their Sum will be the Difference ſought.

Example, in Variety I. Thus you will find, that the Difference of Latitude between London, in 51° 32′ and Madrid, in 40° 15′ to be 11 Degrees and 17 Minutes.

Example, in Variety II. Required, the Difference of Latitude between Paris, in Latitude 48° 30′ North, and Port Danger, the moſt eaſterly Point of New Holland, in Latitude 27° 15′ South. By adding the Latitudes together, the Difference will appear to be 75° 45′ for the Anſwer.

3° [illegible]

PROBLEM VII.

To find the Difference of Longitude between any two given Places on the Globe.

Note. In this Problem there are likewiſe two Varieties, viz. 1ſt. When the given Places have both Eaſt, or both Weſt Longitude. 2d. When they are on different Sides of the firſt Meridian, or one Eaſt, and the other Weſt.

RULE

RULE.

This is ſimilar to the laſt Problem; for when the given Places are both Eaſt, or both Weſt, their Difference will be the Anſwer. But if the one is Eaſt, and the other Weſt, their Sum will be the Anſwer, or Difference ſought.

Thus, according to Variety *Firſt*, the Difference of Longitude between Dublin, in Ireland, in Longitude 6° 25′, and Boſton, in New England, in 70° 30′, both Weſt, will be 64° 5′.

And, according to Variety *Second*, the Difference of Longitude between Liſbon, which is 9° 35′ Weſt, and Botany-Bay, which is 150 Degrees Eaſt, will be 159° 35′.

Note. Should the Sum of the given Longitudes be more than 180 Degrees, ſubtract it from 360, and the Remainder will be the Difference required.

PROBLEM VIII.

The Day of the Month being given, to find the Sun's Place in the Ecliptic.

RULE.

Look for the Day of the Month, which is given on the Horizon, and oppoſite thereto, is the Sign and Degree which the Sun is in; look for the ſame Sign (by its Character) in the Ecliptic Line, upon the Globe; and that particular Degree, which ſtood oppoſite to the Day of the Month, on the wooden Horizon, will be the Sun's Place required.

Thus you will find, that the Sun's Place, on May the 31ſt. and July the 4th. will be found as follows, viz.

May 31ſt. - - -	9° 40′ ♊
July 4th. - - -	12° 13′ ♋

PROBLEM IX.

The Sun's Place being given, to find the Month, and the Day of the Month.

RULE.

This Problem is the Converſe of the laſt, therefore the Pupil need only ſeek the Sign and Degree upon the Horizon, and oppoſite thereto, will be the Day of the Month required.

By acting according to the Rule, you will find, that when the Sun is in 10 Degrees of Libra, it will be October the 3d. When he is 9° 40′ of Gemini, or the Twins, it will be the 31ſt of May; and that 12° 13′ of Cancer, or the Crab, anſwers to July the 4th.

PROBLEM X.

The Latitude of a Place, and Day of the Month being given, to find the Sun's Place in the Ecliptic, and to Rectify the Globe for Uſe.

RULE

RULE. VIII

Let the Sun's Place be found by Problem [redacted] and brought to the eaſtern Side of the Brazen Meridian (ſtaying the Body of the Globe) put the Index of the Hoary Circle to the upper 12, or Noon; elevate the Globe to the given Latitude, ſcrewing the Quadrant of Altitude to the Zenith Point, and placing the Globe due North and South, by the Compaſs: So will the Globe be rectified for Uſe.

Thus, by the Rule will be found, that on the 16th of March, in Latitude 51° 32′ North, the Sun will be in 25° 45′ of Piſces, or the Fiſhes, which I bring to the Meridian, and proceed, as directed by the Rule.

PROBLEM XI.

The Day of the Month being given, to find the Sun's Declination.

RULE.

Find the Sun's Place in the Ecliptic, for the given Day, and bring it to the Brazen Meridian; obſerve the Degree which is directly over it, for that is the Sun's Declination, whether it be North or South.

Example. Required, the Sun's Declination, on May the 17th, and October the ~~24~~ 22th. By obſerving the above, I find, that the Sun's Declination, on May the 17th, is 19° 25′ North; and on the 24th of October, 12 Degrees, South.

PROBLEM XII.

The Latitude of a Place, and Day of the Month being given, to find the Sun's Riſing and Setting, and conſequently, the Length of the Day and Night.

RULE.

Rectify the Globe for the given Latitude, and Sun's Place (by Problem X.) for the given Day; bring the Sun's Place to the Verge of the eaſtern Horizon, obſerving the Hour and Minute pointed at, by the Index, which is the Time of the Sun's Riſing, and being doubled, ſhews the Length of the Night; turn the Globe round, till the Sun's Place touch the weſtern Horizon, and the Hour pointed at, is the Time of his Setting, which being doubled, gives the Length of the Day.

Example, At what Hours of the Day, doth the Sun riſe and ſet, at London, in Lat. 51° 32′ North, on the 21ſt of Auguſt; and the Length of the Day and Night.

ANSWER.

Riſe at 4h. 54m. Length of the Night, 9h. 48m.
Set at 7h. 6m. Length of the Day, 14h. 12m.

PROBLEM XIII.

The Latitude and Day of the Month being given, to find the Sun's Meridian Altitude.

RULE.

Rectify the Globe for the Latitude and Sun's Place, on the given Day, ſtaying the Body of the Globe with a Quill; reckon the Number of Degrees contained between the ſouthern Verge of the Horizon, and the Sun's Place on the Brazen Meridian, and you will have your deſire.

Thus I find that the Sun's Meridian Altitude, on the 10th of October, and the 11th of February, in the Latitude of 51° 32′ North, to be 31° 43′ and 23° 38′.

PROBLEM XIV.

The Latitude of a Place, and the Sun's Meridian Altitude being given, to find the Day of the Month.

RULE.

Rectify the Globe, for the given Latitude, then count on the Brazen Meridian, the given Height, from the ſouthern Point of the Horizon, and where it ends make a Mark; turn the Globe round, till ſome particular Degree of the Ecliptic coincides with the ſaid Mark, noting well the Sign to which it belongs, then look on the Horizon for the ſame Sign and Degree, and oppoſite thereto is the Day required.

Example. Thus, when the Sun's Meridian Altitude, in the Latitude of 51° 32′ North, is 31° 43′ and 23° 38′ I find the Days anſwering to the ſame, to be the 10th of October, and the 11th of February. Proof of the foregoing Problem.

PROBLEM XV.

To find the Length of the Longeſt Day, and the Shorteſt Night; as alſo the Shorteſt Day and Longeſt Night, in any given Latitude.

RULE.

RULE.

Rectify the Globe for the Latitude which is given, bring the firſt Scruple of Cancer to the Meridian, and the Index to the upper 12, repreſenting Noon; then turn the Globe eaſtward, till the Sun's Place lies even with the Horizon, the Index will point to the true Time of his Riſing, and the Hours from 12 at Night being doubled, gives the Length of the Shorteſt Night; turn the Globe round, till the Sun's Place lies even with the weſtern Horizon, when the Index will point to the Time of his Setting, and the Hours from Noon being doubled, gives the Length of the Longeſt Day.

In finding the Shorteſt Day and Longeſt Night, the ſame Rule is to be obſerved; only, inſtead of Cancer, bring the firſt Degree of Capricorn to the Meridian.

Thus, I find that the Length of the Longeſt Day, in the Latitude of 54 Degrees North, by the above Rule, to be 17 Hours, the Shorteſt Night, its Complement to 24, viz. 7 Hours; which reverſed will be the Length of the Shorteſt Day, and Longeſt Night, and vice verſa, for any other Latitude.

PROBLEM XVI.

To find the Difference of the Time of the Day, at any two given Places, and thereby the Difference of Longitude.

RULE.

Let one of the given Places be brought to the Meridian, and the Index to the upper 12, at Noon; then turn the Globe round till the other Place comes to the Meridian, and the Difference of Time will be ſhewn by the Index: By allowing 15 Degrees to every Hour, and 4 Minutes of Time to one Degree, the Difference of Longitude will be likewiſe had.

Thus, for Example, I find, by obſerving the above Rule, that the Difference of Time between London and Conſtantinople, will be 1 Hour and 54 Minutes; and the ſame being reduced into Degrees and Minutes, will be equal to 28° 30′ of the Equator, the difference of Longitude.

PROBLEM XVII.

The Hour of the Day at any Place being given, to find what Hour it is in any other Part of the World.

RULE.

Bring the given Place to the Brazen Meridian, and the Index to the given Hour, then bring the ſecond Place to the Meridian, and the Index will ſhew the Time at any other given Place.

Thus, when it is Noon at London, it is

		H.	M.	
At	Quebec, in Canada, - -	7	5	A. M.
	Port Royal, in Jamaica, -	6	58	A. M.
	Pekin*, in China, - - -	7	46	P. M.
	Copenhagen, in Denmark, -	0	49	P. M.

PROBLEM XVIII.

The Day and Hour at any particular Place being given, to find in what Part of the World the Sun is vertical at the given Moment of Time.

RULE.

Let the Sun's Place be brought to the Brazen Meridian, and mark well what Degree ſtands directly over the ſame; then bring the given Place to the Meridian, and put the Index to the given Time; turn the Globe round till the Index points to 12 at Noon; and that particular Place which ſtands under the obſerved Degree on the Brazen Meridian, is the Place required.

Thus, you will find, on the 16th of May, when it is 10 h. 20 m. P. M. at London, the Inhabitants of Owyhee will have the Sun vertical, or in the Zenith at that given Moment of Time; and ſo for any other Place.

PROBLEM

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[*] This City is variouſly placed by Geographers, in regard to its Longitude; according to this Problem, it is in 116° 30′ of eaſtern Longitude from the Meridian of London, and is that which is had by Obſervation.

PROBLEM XIX.

Any Place within the Torrid Zone being given, to find thoſe Days, when the Sun will be vertical at Noon.

RULE.

Bring the given Place to the Meridian, and mark well its Latitude; then turn the Globe round, and obſerve what Sign and Degree of the Ecliptic paſſeth under the ſame, for thoſe Signs and Degrees being looked for upon the Horizon, will be found oppoſite to the required Days.

Thus, you will find that the Inhabitants of Cape Sandwich, in New Holland, will have the Sun in their Zenith, at Noon, on the 12th Day of November, and 30th Day of January, anſwering to the 20th Degree of Scorpio, or the Scorpion, and 11th Degree of Aquarius, or the Water-bearer; and the Inhabitants of Jamaica, on the 10th of May, and 2d of Auguſt, anſwering to the 20th degree of Taurus, or the Bull, and the 10th of Leo, or the Lion.

PROBLEM XX.

To find what Climate any particular Place is in.

RULE.

Find the Length of the Longeſt Day in the given Place by Problem XV. and the Number of Half Hours which it exceeds 12, gives the Climate required; but if the Climate required be in the Frigid Zones, it will be found in the Table of Climates, in Page 52.

Hence, by the Rule, London, whoſe Longeſt Day, is nearly 16½ Hours, will be found in the 9th Climate.

PROBLEM

PROBLEM XXI.

Any particular Place being given, to find the Antiœci, Periœci, and Antipodes of the ſame.

RULE.

Bring the given Place to the Meridian, and fix the Globe; look on the ſame Meridian, but on the oppoſite ſide of the Equator, for the ſame Latitude, (South, if the given Place be North; or North, if the given Place be South) and under the Degree is the Antiœci of the given Place; ſet the Index to Noon, and turn the Globe round, till it points exactly at the under 12, or Midnight, and fix it again; obſerve what particular Place ſtands now where the given Place did, for that is the Periœci of the given Place; the Antipodes will be found in an oppoſite ſouthern Latitude, as the Antiœci, and on the ſame Meridian with the Periœci.

Thus, the Antiœci of London, is a Point in the Ethiopic Ocean; the Periœci, a Point in Oceanus Magnus; The Antipodes, a Point in the Sea, a little to the South-Eaſt of New Zealand; or rather South-Eaſt from Cape South, the moſt Southern Point.

PROBLEM XXII.

To find how long the Sun ſhines conſtantly, without ſetting in the Frigid Zones, at any given Place; with the firſt and laſt Days of his Appearance.

RULE.

Find how many Degrees the given Place is from the North Pole, (if in the North Frigid Zone) by ſubtracting its Latitude from 90; then count the ſame number of Degrees, upon the Meridian, from the Equator, Northward, particularly marking where the Reckoning ends; turn the Globe carefully round, upon its Axis, and obſerve what two Degrees of the Ecliptic paſs under the ſaid Mark; and oppoſite to thoſe two Degrees, on the Horizon, will be found the Months and Days of the Month when the longeſt Day begins and ends; conſequently how long he will ſhine conſtantly without ſetting. If the Beginning and Ending of the longeſt Night be required, then work with the Complement of ſaid Latitude, towards the South Pole, obſerving the above Directions.

Example. Thus, ſuppoſe it was required to find the Time which the Sun ſhines without ſetting at the North Cape in Latitude 71°. 30′ North. By the Rule it will be found 77 Days, the firſt of his Appearance being on the 14th of May, and the laſt the 29th of July. To the Inhabitants of an equal South Latitude, he will be abſent for the ſame Space of Time; the firſt Day of his Abſence being November 13th, and the laſt the 28th January.

PROBLEM XXIII.

Having the Length of the longeſt Day given, in any Latitude, to find that Latitude.

Let the firſt Degree of Cancer, or the Crab, be brought to the Meridian, and fix the Globe; ſet the Index to Noon; turn the Globe weſtward, till the Index points to half the Number of Hours which the given Day conſiſts of, and fix the Globe again; then move it up and down in the Notches till the firſt Degree of the Sign Cancer lies even with the Horizon; obſerve what Degree appears above the Horizon below the elevated Pole; for that will be equal to the Latitude required.

Proceeding according to Rule, I find, that where the longeſt Day is 17 Hours, the Latitude muſt be 54 nearly.

PROBLEM XXIV.

The Latitude of any Place being given, and the Day of the Month, to find the Hour of the Day when the Sun ſhines.

RULE.

Rectify the Globe, as taught in Problem 10th, and fix a Needle perpendicular in the Sun's Place, in the Ecliptic; turn the Globe round till the Needle makes no Shadow, and fix it; the Index will then ſhew the Hour of the Day. If the given Hour be in the Forenoon, the Needle muſt be fixed on the eaſtern Side of the Meridian; if in the Afternoon on the weſtern Side. This Problem is both eaſy and entertaining.

PROBLEM XXV.

The Latitude of a Place, Day of the Month and Sun's Altitude being given, to find thereby the Hour of the Day, and the Sun's Azimuth.

RULE.

Let the Height of the Sun be exactly taken by a Quadrant of Altitude, and his Place in the Ecliptic be brought to the Brazen Meridian, the Globe being properly rectified to the Latitude; fix the Quadrant of Altitude in the Zenith, and mark on the Quadrant of Altitude, the Sun's obſerved Height, putting the Index of the Hour Circle to Noon; this done, move the Globe and Quadrant of Altitude together, till the Sun's Place in the Ecliptic, and the Degree marked on the Quadrant coincide, the Index will point to the Time of the Day.

For *Example.* Suppoſe in the Latitude of 53° 20′ North, on the 16th June, when the Sun has 16 Degrees of Altitude, the Hour of the Day and Azimuth is required; by the Rule it will be found to be 5 H. 45 M. A. M. and 6 H. 15 M. P. M. the Azimuth, or Angle from the North point at thoſe Times, will be 73° nearly.

PROBLEM XXVI.

The Latitude of a Place, Day of the Month, and Hour of the Day being given, to find the Sun's Altitude.

RULE.

RULE.

Rectify the Globe; find the Sun's Place in the Ecliptic, bring it to the Meridian, and ſet the Index to Noon, ſtay the Body of the Globe with a Quill, and fix the Quadrant of Altitude in the Zenith; turn the Globe till the Index points to the given Hour, and fix it again; move the Quadrant of Altitude till the graduated Edge coincides with the Sun's Place in the Ecliptic; which Place, reckoned upwards on the Quadrant, is the Altitude ſought, and is a Proof of the laſt Problem.

Thus at Sheffield in 53° 20′ North, on the 16th June at 5 H. 45 M. A. M. or 6 H. 15 M. P. M. the Sun's Altitude will be found to be 16 Degrees.

PROBLEM XXVII.

The Latitude of a Place and Day of the Month being given, to find the Beginning of the Morning, and End of the Evening Twilight, with its Duration.

RULE.

Rectify the Globe for the Latitude and Day of the Month, putting the Hour Hand to Noon, or upper 12; this done, bring the Point, which is oppoſite to the Sun's Place in the Ecliptic, to the Meridian, which will be known by the Index pointing to 12 at Night, and mark it with a black Lead Pencil; then let the ſaid Mark be brought to the Weſtern Side of the Globe, moving the Quadrant of Altitude at the ſame Time with the Globe, till 18 Degrees counted upwards coincide with the Point marked in the Ecliptic, which proves that the Sun has then approached within 18 Degrees of the Horizon in the Eaſt, and is the Beginning of the Morning Twilight; the exact Time will be ſhewn by the Index: Turn the Globe Eaſtward, till the Point oppoſite the Sun's Place in the Ecliptic, agrees with 18 Degrees of the Quadrant, and the Index will point to the Time when Twilight in the Evening ends: To find the Duration, turn the Globe till the ſaid oppoſite Point, or Sun's Place, lies even with the Horizon, and the Difference between the Beginning or ending of the Twilight, and the then pointed at Hour will be the Duration; or it is only the Time between Day-break and Sun-riſing, and the contrary.

Note, It often happens, that this Problem is limited; for in ſome Latitudes, the Sun will not reach to the Diſtance of 18 Degrees below the Horizon, for ſeveral Weeks together; as at London, and Places Northward, as far as the Arctic Circle, when the Sun approaches to, and recedes from the northern Tropic: and the ſame in ſouthern Latitudes, when he is approaching towards the Tropic of Capricorn, and till he has receded to ſome diſtance therefrom.

Example. Suppoſe it were required to find the Beginning and Ending of the Morning and Evening Twilight, on the 9th of April, with its Duration, at London, in Latitude 51° 32′ North. By the above Directions, it will appear to begin at 3 h. 15 m. and the Evening Twilight to end at 8h. 45m; the Sun will riſe on the ſame Day at 5h. 22m.; hence we have 5h. 22m.—3h. 15m.=2h. 7m. the Duration.

PROBLEM XXVIII.

To find upon what Point of the Compaſs the Sun riſeth and ſetteth at any Place, the Month and Day being given.

RULE.

Elevate the Pole to the Latitude of the Place; find the Sun's Place, and bring it to the eaſtern Side of the Horizon, and obſerve, in the Circle expreſſing the Points of the Compaſs, upon what particular Point he then riſeth; by turning the Globe to the weſtern Side of the Horizon, you will ſee upon what Point of the Compaſs he ſetteth.

Thus, upon the 10th Day of May, at London, in Latitude 51° 32′ North, the Sun will be found to riſe N. E. by E. ¼ Eaſt, and to ſet N. W. by W. ¼ Weſt, nearly.

PROBLEM XXIX.

A Place on the Globe being given, with its Diſtance from any other Place, to find what other Places on the Globe are at the ſame Diſtance from the given Place.

RULE.

Rectify the Globe for the given Place, and reckon upon the Quadrant of Altitude, the given Diſtance, if under 90 Degrees; if more, uſe the Complement to 180 from the Antipodes, and make a mark on the Quadrant, where the reckoning ends; move the Quadrant quite round upon the Surface of the Globe; and all thoſe Places which paſs under the ſaid Mark, are the Places required.

Example. Required, all thoſe Places on the Globe, which are 1390 Miles from London. By reducing the Miles into Degrees, which are here equal to 20; I make a Mark on the Quadrant, at that Diſtance from the Zenith, and find that the ſaid Mark will paſs over Zant Iſle, on the Coaſt of Greece; Adrianople, in Turky in Europe; and Gt. Novogorod, in Ruſſia.

PROBLEM XXX.

Given, a Place upon the Globe, to find all other Places that are ſituate from the ſame, upon any deſired Point of the Compaſs.

RULE.

Elevate the Pole to the Latitude of the given Place, and let the ſame be brought to the Brazen Meridian; fix the Quadrant of Altitude in the Zenith, and apply its graduated Edge to the deſired Point of the Compaſs; obſerve what Places lie even with the ſaid Edge of the Quadrant, for thoſe are the required Places.

Thus, Fatali Iſle, near the Mouth of the River Amazons, and the N. W. Part of Lake Xarayes are S. W. by W. from London.

Dunkirk, Bern, Genoa, Meſſina, and the Comoro Iſles, S. E. Dunagal, in Ireland, an Iſland at the South Point of Greenland, Cape St. Lucas, in California, and Iſle St. Thomas, in the South Sea, will be found N. W. by W. of London.

PROBLEM XXXI.

To find the Angle of Poſition between any two Places, or the Angle which the Arch of a great Circle paſſing through two given Places, makes with the Meridian of either of them, formed in their reſpective Zeniths.

RULE.

Rectify the Globe for one of the given Places, bring the ſame to the Brazen Meridian, and fix the Globe, ſcrew the Quadrant of Altitude to the Zenith, and lay the graduated Edge thereof, over the other given Place, which will cut the required Angle on the Horizon, reckoned from the neareſt North or South Point.

Thus, the Angle of Poſition from London to Rome is 47½ Degrees; but the Angle from Rome to London is 49 Degrees. The Angle of Poſition from the Lizard to Barbadoes is 71 Degrees, nearly; and from Barbadoes to the Lizard, only 37½.

PROBLEM

PROBLEM XXXII.

The Day and Hour being given, to find thoſe Places on the Globe, where the Sun is then riſing, making Noon, and ſetting.

RULE.

Find what Part of the Globe has the Sun then vertical, and bring the ſame to the Meridian (rectifying the Globe to the Latitude of the ſame) fix it, and obſerve what places are in or near the Horizon, on the Weſt; for to theſe, the Sun is riſing. Look what Places are in the Horizon, on the Eaſt Side of the Globe, for to theſe is the Sun ſetting; thoſe under the Meridian have Noon, and thoſe on the oppoſite Meridian have Midnight: This is ſo plain, that it needs no Example.

PROBLEM XXXIII.

The Latitude of a Place, Month, and Day of the Month, together with the Moon's Latitude and Place in the Ecliptic, being given, to find the Time when the Moon will riſe, ſet, and ſouth, or come to the Meridian of the given Place.

RULE.

Rectify the Globe to the Latitude and Sun's Place, putting the Index to Noon; then find the Moon's Place, by Mr. White's Ephemeris, or any other Almanack, wherein the Places of the Planets are calculated for every Day at Noon (regarding her Latitude) mark the ſame with Chalk, Pencil, Patch, or Character; turn the Globe round, till the Moon's Place lies even with the Horizon in the Eaſt, and the Index will ſhew the Hour of her Riſing; turn the Globe weſtward, till the ſaid mark comes to the Brazen Meridian, which will be the Time of her Southing; continue to turn the Globe weſterly, till her Place coincides with the weſtern Verge of the Horizon, and you will have the Time of her Setting by the Index accordingly.

Note. This will not ſhew the exact Time of her ſouthing and ſetting, on Account of her ſwift Motion in the Ecliptic; but if you allow about ½ a Degree for each Hour after the Time of her Riſing, the Time of her ſouthing and ſetting will be had pretty accurate.

Thus you will find, that on the 29th of October, 1787, at London, in Latitude 51° 32′ North, the Moon being in 13° 45′ of Gemini, and her Latitude 1° 15′ North; that ſhe will riſe at 6 Hours 40 Minutes P. M. will come to the South about 2 Hours 35 Minutes, and ſet at about 11 Hours 15 Minutes A. M. on the following Day.

PROBLEM XXXIV.

The Day and Hour of a Lunar Eclipſe being given, to find all thoſe Places of the Earth to which the ſame will be viſible.

RULE.

Find that Place upon the Globe to which the Sun will be vertical at the given Moment of Time, then the

Place which is diametrically oppoſite thereto, for that is the Place to which the Moon is vertical at the Time of Oppoſition or Full; mark the ſaid Place to which the Moon is vertical, and rectify the Globe for the ſame: the Globe remaining in this Situation, will preſent you with a View of all thoſe Places or Parts of the Earth, where the Eclipſe will be viſible.

Example. The Moon will be eclipſed on the 30th of June, 1787, at about 2, P. M. conſequently viſible to the Inhabitants of Botany Bay; all Parts of New Holland; New Zealand; Society Iſles; New Hebrides; Friendly Iſles; New Guinea; New Britain; New Ireland; New Calodonia, &c.

Note. It will often happen that an Eclipſe of the Moon may be ſeen in more Hemiſpheres than one; occaſioned by the Earth's Rotation on her Axis, and the Breadth of her denſe and penumbral Shadow at the Diſtance of the Moon.

The ſame Rule is generally given for determining the Places of the Earth, to which Solar Eclipſes are viſible, i. e. by bringing that Part of the Earth to the Pole of the Horizon, where the Sun is vertical at the Time of Conjuction; but this is by no means to be depended upon; the Moon's Shadow involving ſo ſmall a Portion of the Earth's Surface in Darkneſs, and inclined according to the Moon's Latitude, which (though ſmall) will render an Anſwer by the Globe very uncertain. This Problem is allowed, even by Aſtronomers, to be one of the moſt tedious Taſks they meet with.

PROBLEM XXXV.

Two Places being given, to find the true Diſtance between them.

RULE.

Bring one of the given Places to the Meridian, and apply the Quadrant of Altitude from it to the other given Place; the Degrees intercepted between them, reduced into Miles, will give the Anſwer; Or, the Diſtance may be taken by a Pair of Compaſſes, and aſcertained upon the Equator in Degrees.

Note. In reducing Degrees into Miles, obſerve that a Degree contains 60 Nautical, or 69½ Geographical or Engliſh ſtatute Miles; which laſt is nearly the true Meaſure of a Degree in a great Circle of the Sphere, as was firſt proved by our ingenious Countryman Mr. Norwood, and afterwards confirmed by ſeveral eminent French Aſtronomers, who had been ſent on purpoſe to different Parts of the Globe, which has redounded much to the Honour of that Nation.

Fxample. Thus the Diſtance from London to Rome is 13 Degrees, and is equal to 780 Nautical, or 903½ Engliſh Miles; the ſame is to be obſerved for any other Place.

Note. The true Diſtance between any two Places that differ both in Latitude and Longitude, is readily, and exactly determined, by ſpherical Trigonometry, where two Sides, and the contained Angle are given, to find the third Side. I mention this, that the Pupil, who may have made himſelf acquainted with thoſe noted Rules, ſhould find Employment, in proving any Operation by the Globe, or ſatisfy his Curioſity, when peruſing any Table of the Latitudes and Longitudes of Places, or the Diſtances of Stars whoſe Latitudes and Longitudes are known, &c..

PROBLEM XXXVI.

The Latitude and Day of the Month being given, to find the Sun's Amplitude, or how much he either riſes or ſets, from the true Eaſt and Weſt Points of the Compaſs, together with that Point of the Compaſs, which he riſes or ſets upon.

RULE.

Rectify the Globe, and bring the Sun's Place to the eaſtern Side of the Horizon, and obſerve what Number of Degrees on the Amplitude Circle, are contained between that particular Place, and the true Eaſt and Weſt Points; for that is the Amplitude, whether it be towards the North or South; and upon the Circle of Rhumbs will be ſhewn the Point of the Compaſs he riſes or ſets upon; turn the Globe round, till the Sun's Place lies even with the Horizon, in the Weſt, and obſerve as before, and you will have your deſire.

Thus, at London, on the 10th of January the Sun's Amplitude at riſing will be 36½ Degrees from the Eaſt, ſoutherly; likewiſe he will riſe at S. E. by E. ¼ S. his Amplitude at ſetting will be 36½ Degrees from the Weſt, ſoutherly, and S. W. by W. ¼ S.

PROBLEM XXXVII.

The Sun's Declination being given, to find the Riſing and Setting of the Sun, for any particular Place, or at all Places upon the Face of the Earth; alſo, to ſhew all thoſe Places to which the Sun is riſing, ſetting, and making Noon; with the Length of the Days and Nights, the Circle of Illumination, &c.

RULE.

Elevate the Pole to the Declination; bring your Habitation, or any other particular Place to the Meridian, and the Index to 12 at Noon; obſerve what Places paſs under the ſaid Degree of Declination, for to all thoſe Places the Sun will be vertical on that Day, which anſwers to the Declination: to all Places in the weſtern Side of the Horizon, the Sun is riſing; on the contrary to all Places in the eaſtern Side, he is ſetting; all Places, as they arrive at the Brazen Meridian, have Noon, whilſt thoſe on an oppoſite Meridian have their Midnight; And as the Sun conſtantly illuminates one Half of the Globe, you will, with pleaſure, obſerve the Circle of Illumination, or that which ſeparates between Light and Darkneſs, which ſhews what Parts of the Earth have long or ſhort Days, and where it is all Day or all Night, with the different Lengths of each, &c.

Thus, you will find, when the Sun has 23½ Degrees, or the greateſt Declination North, that the Length of the Day at London, will be 16h. 26m. at Hull, 16h. 40m. at Newcaſtle, 17h. 6m. at Edinburgh 17h. 12m. Kirkwall, in the Orkneys, 17h. 27m. at Copenhagen in Denmark, 17h. 7m. at Conſtantinople, 14h. 53m. Rome 15h. Jeruſalem 14h. Cairo 13h. 48m. Botany Bay, 9h. 45m. the North Frigid Zone will be entirely in the Sun-ſhine, and the South Frigid Zone deprived of the Benefit of that all-chearing Regent, and ſo for all other Places and Seaſons, in different Degrees of Declination, North or South.

Note. In this Problem (which is one of the beſt that can be performed upon the Terreſtrial Globe) the Sun is ſuppoſed at reſt, and the Earth actually performing her diurnal and annual Motions.

PROBLEM XXXVIII.

The Month and Day being given, to find thoſe Places of the North Frigid Zone, where the Sun begins to ſhine conſtantly, without ſetting; as alſo thoſe Places of the South Frigid Zone, where the Sun begins to be totally abſent.

RULE.

Find the Sun's Declination for the given Day, and ſubtract the ſame from 90 Degrees, the Remainder will be the Latitude of all thoſe Places, where the Sun begins to ſhine conſtantly without ſetting; obſerve the ſame Latitude South, and you will have all thoſe Places where he begins to be totally abſent.

Note. This is underſtood to be either in the firſt or third Quarter of the Ecliptic; and there is no need of rectifying the Globe.

PROBLEM XXXIX.

A certain number of Days, not exceeding 182, being given, to find the Parallel of Latitude, on the Globe, where the Sun ſetteth not, during thoſe Days.

RULE.

Take half the number of Days, and with that Number count ſo many Degrees, either eaſterly or weſterly, from the Beginning of Cancer, and make a Mark on the Ecliptic, where the Reckoning ends; but you are to obſerve, that if half the number of Days exceed 30, you are to reckon one Degree leſs; if 60, 2 Degrees leſs; and if 90, 3 Degrees leſs; (for the Days of the Year, and Degrees of the Ecliptic, or of any other Circle are not equal) bring the Place or Point, which you have marked, to the Brazen Meridian, and obſerve how many Degrees are intercepted between the ſaid Point and the Pole, for the ſame is equal to the deſired Parallel of Latitude: if the deſired Parallel be South of the Equator, the Operation will be the ſame, when you have brought the firſt Degree of Capricorn to the Meridian.

Example. In what Parallel of North Latitude doth the Sun ſhine for 140 Days, without ſetting.

By the Rule the Parallel will be in 81 Degrees North.

PROBLEM XL.

A Place, its Latitude, and true Diſtance from a ſecond Place, together with the Latitude of the ſecond Place, being given, to find that Place.

RULE.

Rectify the Globe for the given Place, and fix the Quadrant of Altitude in the Zenith, and reckon upon it the true Diſtance backwards from the Zenith, let a fine Black-lead Pencil, or piece of Chalk, be held exactly over the Latitude of the required Place, againſt the Brazen Meridian, in ſuch a manner, that by turning the globe round, it may deſcribe a curve of a convenient Length; let the given Place be brought again to the Meridian, and fix the Globe; move the Quadrant of Altitude, till the Mark upon it cut the ſaid Arch, or Curve-line, which it will do upon the required Place.

Thus, London being given, in Latitude 51° 32′ North, and another Place lying eaſterly, in Latitude 29° 50′ North, diſtant 40 Degrees; by the Problem, the Place will be found to be Baſſora, in Arabia, near the Mouth of the Euphrates.

PROBLEM XLI.

A Place, its Latitude, and true Diſtance from a ſecond Place, together with the Longitude of the ſecond Place being given, to find that Place.

RULE.

Rectify the Globe, and fix the Quadrant of Altitude in the Zenith; mark the given Diſtance upon it reckoning backwards from the Zenith; bring the given Longitude to the Braſs Meridian, and with a Black-lead Pencil deſcribe an Arch of a Circle, along the Meridian, at pleaſure; bring the given Place again to the Meridian, and fix the Globe; this done, move the Quadrant of Altitude, till the Diſtance marked upon it, coincides with the ſaid Arch, which was deſcribed along the Side of the Meridian, and where it cuts it, is the Place required.

Thus, for Example.—Suppoſe Edinburgh, in Scotland, in Latitude 55° 30′ North, diſtant 37½ Degrees from another Place in Longitude 41¼ Eaſt of the Meridian of London; By following the above Rule, the required Place will be found to be Anna, a Town ſituate upon the Euphrates, in Arabia Deſerta.

PROBLEM XLII.

Two Places under the ſame Meridian, with their Latitudes, and the reſpective bearing of a third Place (unknown) by the Compaſs, being given, to find that Place, and its true Diſtance from the other two.

RULE.

Rectify the Globe for one of the given Places, and lay the Quadrant of Altitude to the given Point of the Compaſs, on the Horizon, drawing a Line cloſe by the graduated Edge of the ſame, with Chalk, or a Black-lead Pencil; this done, let the Globe be rectified for the ſecond Place, and lay the Quadrant to the given Point of bearing on the Horizon, drawing a Line as before, and where thoſe Lines interſect each other, is the required Place; their Diſtances are had by the Quadrant, as uſual.

Thus, ſuppoſe a Place, whoſe bearing from London, in Latitude 51° 32′ North, is E. S. E. and from Semara, in Negroland, (in Latitude 17 Degrees North.) N. E. by E. was required. It will be found to be Jeruſalem, diſtant from the former 32¾ Degrees, and from the latter 35 Degrees.

PROBLEM XLIII.

A Place and its Latitude being given. to find how all other Places bear from that Place, by ſo many Angles of Poſition.

RULE.

Rectify the Globe to the given Place, and fix the Quadrant of Altitude in the Zenith; turn it all round the Surface of the Globe, and the ſeveral Angles of Poſition will be ſeen upon the Line of Rhumbs, or Azimuth Circle.

Thus, for Example—The Angle of bearing in an Arch of a great Circle, from London, to

Boſton, in New England, is -	W. N. W. ¼ W.
Fez, in Morocco - -	S. by W. ¼ W.
Rome, in Italy - -	S. E. ¼ E.
Conſtantinople - -	E. S. E. ½ E.
Vienna, in Germany - - -	E. by S.

Warſaw,

Warſaw, in Poland	E. by N. a little N.
Berlin, in Pruſſia	E. by N. ¼ N.
Copenhagen, in Denmark	N. E. by E. ¼ N.

PROBLEM XLIV.

Several Places and their Latitudes being given, to find how any particular Place bears from them all, by ſo many Angles of Poſition.

RULE.

Rectify the Globe for each Place (as in the laſt Problem for London) and the Quadrant of Altitude laid over the Place whoſe bearing is required, will ſhew the Angle upon the Horizon.

Thus, London will be found to bear from

Boſton, in New England	N. E. ½ E.
Fez, in Morocco	N. ½ E.
Rome, in Italy	N. W. ¼ N.
Conſtantinople	N. W. by W.
Vienna, in Germany	W. N. W.
Warſaw, in Poland	W. ½ N.
Berlin, Pruſſia	W. ¼ S.
Copenhagen, in Denmark	W. S. W.

PROBLEM XLV.

The Day of the Month being given, to find what other Day of the Year, will be of the ſame Length with the given Day.

RULE.

RULE.

Bring the Sun's Place to the Meridian, and mark what Degree of the Brazen Meridian it paſſeth under, for that is the Declination for the given Day; let the Globe be moved round, till ſome other Degree of the Ecliptic comes under the ſaid Mark on the Meridian, and that will be the Sun's Place, for the required Day; then look on the Horizon, and oppoſite to the ſaid Degree, is that Day, which is of the ſame Length with the given Day.

Thus, for Example—The 10th of May will be of the ſame Length with the 2d of Auguſt; and the 19th of October, with the 22d of February.

PROBLEM XLVI.

The Latitude of a Place, and Day of the Month being given, to tell at what Hours of the Day the Sun will be due Eaſt and Weſt, within the Compaſs of the Horizon.

Note. This can only happen in north Latitudes, when the Sun is upon the Equinoctial, or ſomewhere north of it; for when he has ſouth Declination, his Eaſting and Weſting will be below the Horizon.

RULE.

Rectify the Globe for the given Latitude; then find the Sun's Place in the Ecliptic, for the given Day, and mark it; bring the ſame to the Meridian, and fix the Globe; turn the Index to the upper 12, and fix the Quadrant of Altitude in the Zenith; lay the lower End to the eaſt Point of the Compaſs, or Horizon, and keep it there; turn the Globe gently round upon its Axis, till the Sun's Place coincides with the graduated Edge thereof, and the Index will point to the Time required.

Thus, at London, in Latitude 51° 32′ North, on the 12th of April, the Sun will be due Eaſt, at 6h. 30m. and due Weſt at 5h. 30m. On the 8th of Auguſt, he will be due Eaſt, at 6h. 52m. and due Weſt 5h. 8m.

PROBLEM XLVII.

When the Sun has ſouth Declination, or in other Words, when the Latitude and Declination, are of different kinds, to find when the Sun will be due Eaſt or Weſt.

RULE.

If the Latitude be North, and the Declination South, you muſt elevate the South Pole to the given Degree of Latitude, and bring the Sun's Place to the Meridian, and fix the Globe; turn the Index of the Hoary Circle, to the 12 that would repreſent Noon, were the North Pole above the Horizon; fix the Quadrant of Altitude in the Zenith, laying it to the Eaſt Point, as before, in Problem XLVI. turn the Globe gently round, till the Sun's Place meets the graduated Edge of the Quadrant of Altitude, then will the Index point to an Hour whoſe Complement to 12, will be the true Time of the Sun's Eaſting; lay the Quadrant to the Weſt Point of the Horizon, turning the Globe as before, till the Sun's Place meet the ſame, and the Index will point out the Complement of the true Time of Weſting.

Thus, on the 11th of November, at London in Latitude 51° 32′ North, the Sun will be found by the foregoing Rule, to be Eaſt, at about 5 o'Clock, and due Weſt about 7. On December the 1ſt at the ſame Place, he will be due Eaſt at ¼ paſt 4, and due Weſt ¾ before Eight.

PROBLEM XLVIII.

The Latitude of a Place being given, to tell the Hour of the Day at any Time when the Sun ſhines.

RULE.

Elevate the Globe to the Latitude, and place the Globe due North and South by the Compaſs (allowing for Variation). The Hoary Circle will in this Caſe become a Polar Sun Dial, and the Axis of the Globe, the Gnomon or Stile, the Shadow of which will ſhew the Hour of the Day.

PROBLEM XLIX.

Any Parallel of Latitude being given, to find how many Miles make a Degree of Longitude, in that Parallel.

RULE.

With a Piece of Wire, or ſome pliant Zone, that will bend properly, take off any number of Degrees from the given Parallel, and apply the ſame Diſtance to the Equator, obſerving how many Degrees it makes there; (which will always be a leſs Number than in the Parallel) bring ſuch Degrees into Miles, and divide by the number of Degrees taken in the Parallel; the Quotient will be the Anſwer.

Thus, ſuppoſe it were required, to tell how many Miles are contained in a Degree of Longitude, in the Parallel of 53° 20′; by taking 20 Degrees from the Globe, in that Latitude, and applying the ſame to the Equator, it will be found to make but 11° 57′, which I reduce into Miles, and divide by 20. Hence the Anſwer is 35,8 Miles.

The ſame performed by Trigonometry.

As Radius - - - -	10,0000000
To the Sine Complement of 53° 20′	9,7760897
So is 60 - - - - -	1,7781513
To 35,8295 - - - -	1,5542410

Very near the ſame as above.

Note. Some Authors recommend taking the Degrees in the required Parallel, by a Pair of Compaſſes, or Dividers; but, whoever follows that Method, will be led into an Error; and the greater the Diſtance ſo taken, the greater will ſuch Error be; for any one, who has ever uſed a pair of Dividers, in the diviſion of a Circle, muſt know, that the Chord, inſtead of the Arch, will be the reſult of every ſuch Operation.

PROBLEM

PROBLEM L.

The Longeſt Day in any Latitude being given, to find in what other Latitude, the longeſt Day is one, two, three, or more Hours, or any other given Time, longer or ſhorter than the Day given.

RULE.

Let the Globe be rectified for Uſe, to the given Latitude, and the ſolſtitial Colure, which makes the longeſt Day, at the given Place, be brought to the Brazen Meridian, and the Globe, fixed with a Quill; obſerve where the eaſtern Side of the Horizon cuts the Tropic of Cancer (if the Place be in North Latitude) and make a Mark with a Pencil; turn the Globe weſtward, till as many Times 7½ Degrees of the Equator paſs the Meridian as the longeſt Day in the required Latitude, conſiſts of Hours more than the given Day; then fix the Globe again, look for the ſame Tropic Line, and make another mark, with a Pencil, againſt the Edge of the Horizon; bring the 1ſt of Cancer back to the Meridian, and fix the Globe, elevate the North Pole, till the 2d Mark appears, and the required Latitude will be found accordingly, by obſerving the Degrees under the elevated Pole.

Note. When the Day is to be any Number of Hours, ſhorter that the given Day, the Degrees muſt paſs eaſtward, and the Pole be depreſſed, till the 2d Mark appears, and the Latitude will be had as above.

Thus, by the Rule, the Latitude where the longeſt Day is one Hour longer than at London, will be found to be 56° 30′ North; and the Latitude where the longeſt Day is one Hour ſhorter, will be 45° 20′ North.

PROBLEM LI.

The Latitude of a Place, and the Sun's Declination being given, to find thoſe particular Times of the Day, when the Sun will be twice in the Forenoon, and twice in the Afternoon, upon the ſame Azimuth, or Point of the Compaſs.

Note. This can no where happen but in the Torrid Zone, and the Declination and Latitude of the ſame Side of the Equator; alſo, the Declination muſt exceed the Latitude of the given Place.

RULE.

Rectify the Globe to the Latitude of the Place, and let the Sun's Declination be marked on the Brazen Meridian; turn the Globe, till ſome part of the Ecliptic, on either Side of the Tropic of Cancer (if in North Latitude) coincides with the Declination, and mark it alſo; fix the Globe, then put the Index to Noon, and ſcrew the Quadrant of Altitude to the Zenith; bring the Sun's Place to the eaſtern Side of the Horizon, and obſerve the Hour of the Sun's riſing, as well as the Azimuth, or Point of the Compaſs, which he riſes upon; keep the Quadrant of Altitude to this Point; turn the Globe gently round on its Axis, towards the Weſt, and you will ſee the Curve, which the Sun ſeems to deſcribe in the Heavens; when the Sun's Place again touches the gratuated Edge of the Quadrant, the Sun will then be on the ſame Point of the Compaſs, as at his Riſing, which Time will be ſhewn by the Index. The ſame curious Phænomena takes place in the Afternoon, when the Quadrant is laid to the ſetting Point.

Thus, at Jamaica, whoſe Latitude is 17° 40′ North, when the Sun's Declination is 20 Degrees North; he will be found to be on the ſame Azimuth, or Point of the Compaſs, at 5h. 33m. and 11h. 22m. A. M. being E. N. E. a little Eaſt; and in the Afternoon, at 0h. 38m. and 6h. 27m. or W. N. W. a little Weſt.

PROBLEM LII.

OF THE HARVEST MOON.

This is the Moon which is full at the autumnal Equinox, or a little before or after it; and is remarkable for riſing nearly at the ſame Hour, for ſeveral Nights together. This very curious Phænomena is wholly occaſioned by the Obliquity of the Ecliptic in thoſe Signs (Piſces and Aries); hence a larger Portion riſes in a ſmaller Space of Time; but, although the above takes place, her Southing will be, as uſual, about 48 Minutes later each Night.

For our preſent Purpoſe we will chuſe three Days before, and three Days after the Day of full Moon, in September, 1787; the Sun's Place, Moon's Place, and her Latitude, as follow, viz.

The

The TABLE.

	Sun's Place.	Moon's Place.	Moon's Lat.
Sept. 24th -	1° : 19′ ♎	27° : 12′ ♒	4° : 11′ North
25 -	2 : 18	10 : 14 ♓	4 : 42
26 -	3 : 17	23 : 36	4 : 58
27 -	4 : 16	7 : 17 ♈	4 : 58
28 -	5 : 15	21 : 14	4 : 41
29 -	6 : 14	5 : 22 ♉	4 : 6
30 -	7 : 13	19 : 36	3 : 15

Thus by Problem XXXIII. (for there needs no other Direction) the Moon will riſe at London in Latitude 51° 32′ North, on the given Days, as under, nearly.

Moon's Riſing.

	H.	M.
Sept. 24th -	4	22
25 -	4	45
26 -	5	4
27 -	5	26
28 -	5	45
29 -	6	10
30 -	6	45

Thus, for ſeven Days together ſhe will not differ much more than two Hours in riſing, and yet her Southing will be as uſual.

PART IV.

Of the ANALEMMA, ſhewing its Uſe in the Solution of PROBLEMS.

THE ANALEMMA, as it is called, is a narrow Slip of Paper, whoſe Length is equal to the Breadth of the Torrid Zone, and laid acroſs on ſome convenient Place; generally in a Part of the great Pacific Ocean, weſt of California.

The Analemma contains all the Months and Days of the Year, divided into two Parts. The firſt Part begins at the Bottom, with the Winter Solſtice, and is reckoned northerly to the Summer Solſtice, where the ſecond Part begins, and is reckoned towards the South in like Manner.

Thus it is plain thoſe ſeveral Days muſt correſpond with the Sun's Declination the Year about.

PROBLEM I.

The Day of the Month being given, to find the Sun's Declination.

RULE.

Bring the Middle of the Analemma to the Meridian, and obſerve what Degree ſtands directly over the given Day, for that will be the required Declination.

Thus, on the 10th of March, the Sun's Declination is 4° S; on the 15th of April 10° N; on the 27th of May 21½; on the 14th of October 8¾° South.

Note. There is no Occaſion for rectifying the Globe in this Problem, the Latitude being out of the Queſtion.

PROBLEM II.

The Latitude of a Place and the Day of Month being given, to determine the Sun's Riſing and Setting, with his Amplitude.

RULE.

Rectify the Globe, and bring the Middle of the Analemma to the Edge of the Brazen Meridian, and the Index of the Hoary Circle to the 12 at Noon.— Turn the Globe eaſtward till the given Day lies even with the Horizon, and the Index will ſhew the Hour of Riſing, and, oppoſite the given Day upon the Horizon, will the Amplitude be found. Turn the Globe weſtward till the given Day correſponds with the Horizon in the Weſt, and the Time and Amplitude will be had as before.

Thus, on the 14th of May, in Latitude 51° 32′ North, the Sun will riſe at 15 Minutes paſt Four, and ſet 15 Minutes before Eight; his Amplitude 31½ Degrees northerly. On the 11th of June he will riſe at ¼ paſt Three, and ſet at ¼ before Nine; his Amplitude 39 Degrees from the Eaſt and Weſt northerly.

PROBLEM III.

The Latitude of a Place, the Day of the Month, and the Hour being given, to find the Sun's Altitude and Azimuth.

RULE.

Rectify the Globe to the Latitude of the Place; bring the Middle of the Analemma to the Brazen Meridian, and the Index to 12 at Noon; fix the Quadrant of Altitude in the Zenith; turn the Globe till the Index points to the given Hour; lay the graduated Edge of the Quadrant over the given Day, and fix the Globe: that Degree of the Quadrant which cuts the given Day, is the Altitude; and, the Number of Degrees intercepted between the Edge of the Quadrant and North or South Point of the Compaſs, is the Sun's required Azimuth,

Thus, on the 20th of May, at London, in Latitude 51° 32′ North, the Sun's Altitude at 9 A. M. will be 43 Degrees, and his Azimuth 66½ Degrees from the South, eaſterly, or E. S. E. nearly.

PROBLEM IV.

The Latitude of a Place, the Day of the Month, and the Sun's Azimuth being given, to find the Hour of the Day when the Sun will come upon that Azimuth, together with the Altitude of the Sun.

RULE.

RULE.

Let the Globe be rectified, and the middle of the Analemma brought to the Meridian, as in the foregoing Problems; as alſo the Index to Noon, and the Quadrant ſcrewed to the Zenith; lay the Quadrant of Altitude to the given Azimuth, and turn the Body of the Globe gently round, till the given Day in the Analemma meets the graduated Edge of the Quadrant, and then fix it with a Quill; obſerve the Hour pointed at by the Index, for that is the Time when the Sun arrives to the given Degree of Azimuth; and the Degree of the Quadrant, which coincides with the given Day, is the Altitude at that Time.

Thus, at Sheffield, in Latitude 53° 20′ North, on the 15th of March, when the Sun's Azimuth is 64° from the South, the Time of the Day will be found to be 8 h. 2 m. A. M. and the Sun's Altitude, at that Time, 16½ Degrees: Alſo, on the 11th of June, in the ſame Latitude, when the Sun has 47° of Azimuth from the South, the Time will be 10 h. 5 m. A. M. and his Altitude 53 Degrees.

PROBLEM V.

The Latitude of a Place and Hour of the Day being given, to find all the different Azimuths and Altitudes the Sun can have, at the given Hour, on every Day of the Year.

RULE.

RULE.

The ſame Directions as given in Problem 3d, will anſwer this Problem, which being repeated for every Day, all the required Azimuths and Altitudes will be obtained. An Example will be unneceſſary.

PROBLEM VI.

The Latitude of a Place, the Day of the Month, and the Sun's Altitude being given, to find from thence his Azimuth, and the Time of the Day.

RULE.

Rectify the Globe for Uſe, and move the Globe and Quadrant of Altitude together, till the given Day and Degree of Altitude agree with each other. This done, obſerve the Hour pointed at by the Index, which will be the required Time; and where the graduated Edge cuts the Horizon will be the required Azimuth.

Thus, for Example, at Sheffield, in 53° 20′ North, June 16th, the Sun's Altitude 16 Degrees; the Hour of the Day will be 5h. 40m. A. M. and his Azimuth at that Time 70 Degrees from the North, eaſterly: being E. N. E. ¼ E. nearly.

PART

PART V.

CONTAINING

Twenty-five THEOREMS, or undeniable Truths, deduced from the foregoing PROBLEMS: and very neceſſary for the Reader to be acquainted with.

THEOREM I.

THE Latitude of any Place is equal to the Elevation of the Pole above the Horizon of the ſame.

THEOREM II.

The Elevation of the Equator above the Horizon, in any Place, is always equal to the Complement of the Latitude.

THEOREM III.

All Places ſituate upon the Equator, have no Latitude; it being there that the Computation takes Place.

THEOREM IV.

Places under the Poles have the greateſt Latitude, becauſe there the Computation of Latitude ends.

THEOREM V.

Places ſituate on the firſt Meridian have no Longitude, it being from thence that the Longitude is reckoned; and, at the Interſection of the Equator, neither Latitude nor Longitude.

THEOREM VI.

Places lying 180 Degrees Eaſt or Weſt of the firſt Meridian, have the greateſt Longitude; it being there that the Computation ends.

THEOREM VII.

All the Inhabitants of the Earth have the Points of the Compaſs diſtinguiſhed in the Horizon, except at the two Poles; for, from the North Pole, every Point bears South; and, from the South Pole, every Place will bear North. And whichſoever Way the Wind bloweth at the North Pole, it muſt come from the South, and the Contrary.

THEOREM VIII.

All Places, upon the Face of the Earth, do equally enjoy the Light of the Sun, in Reſpect to Time, and are equally deprived of the Benefit of that glorious Luminary.

THEOREM IX.

In all Places of the Earth the Days and Nights are equally long (ſave at the two Poles) when the Sun comes upon the Equinoctial Line, in March and September.

THEOREM

THEOREM X.

All Places under the Equator have the Days and Nights of an equal Length throughout the Year, notwithſtanding the Sun's Declination; which is manifeſt from the Poſition of the Sphere; one Half of the Equator being always above the Horizon, and the other always below it; as well as all the different Parallels of Latitude.

THEOREM XI.

To no ſingle Place between the Equator and the Poles, is the Day and Night equal, except at thoſe Times when the Sun enters Aries ♈ and Libra ♎.

THEOREM XII.

When the Sun's Declination exceeds the Latitude of the Place, on either Side of the Equator, the Sun will come twice in the Forenoon, and twice in the Afternoon, upon the ſame Azimuth or Point of the Compaſs.——See Problem LI.

THEOREM XIII.

To all Places in the ſame Parallel of Latitude, the Days will be of an equal Length; whether they be long or ſhort.

THEOREM XIV.

The nearer any Place is to the Equator, the leſs will be the Difference between the Days and Nights, in that Place, the more diſtant the contrary.

THEOREM

THEOREM XV.

To all Places within the Tropics, the Sun is Vertical, or in the Zenith twice in the Year, to thoſe at the Tropics but once, and to other Places of the Earth, never.

THEOREM XVI.

To all Places in the Torrid Zone, the Duration of Twilight will be the leaſt, the Sun's Path being the moſt perpendicular to the Horizon; and to all Places in the Frigid Zone the greateſt, the Sun's Path being there the moſt oblique to the Horizon: in the Temperate Zones, at a Medium between the two, becauſe the Obliquity of the Ecliptic is ſo.

THEOREM XVII.

All Places which lie exactly under the Polar Circles, will have the Sun when in the neareſt Tropic 24 Hours above the Horizon, without ſetting; and the reverſe happens when he is in the fartheſt Tropic. At all other Times of the Year, he will riſe and ſet as at other Places.

THEOREM XVIII.

To all Places between the Equator and the Polar Circles, the longeſt Day and ſhorteſt Night, is, when the Sun is in either Tropic, that is, when he enters Cancer, the Days are longeſt and Nights ſhorteſt to the Inhabitants of the northern Side; and to thoſe on the ſouthern Side, when he enters Capricorn.

THEOREM XIX.

To all Places between the Polar Circles and the Poles, the Sun will make ſeveral diurnal Revolutions, without ſetting, becauſe a Part of the Ecliptic ſets not to the ſaid Places; the contrary will happen, when he is in the oppoſite Signs, and vice verſa, more or leſs, as the Places are nearer to, or farther from the Poles.

THEOREM XX.

If a Ship ſets out from any Port, and ſails round the Globe, weſtward, the People in ſaid Ship will loſe one whole Day, at their return; or, which is the ſame thing, they will reckon one Day leſs than the People at the ſaid Port; the contrary will happen by ſailing eaſtward round the Globe, which was proved by Commodore Anſon, and Capt. Cook.

THEOREM XXI.

Should two Ships ſet ſail from the the ſame Port, the one eaſt, and the other weſt, round the Globe, the People in thoſe Ships will differ two complete Days at their return, though they ſhould arrive on the ſame Day and Hour.

THEOREM XXII.

Should a Ship ſail round the Globe, upon a Meridian, any number of Times, the People in that Ship will differ nothing in reckoning their Time from the People at the Port from whence they ſailed; not having altered their Meridian.

THEOREM XXIII.

Should two Ships ſail from different Ports, either due Eaſt or due Weſt, by an Angle of Poſition with the Meridian of each Place, thoſe Ships ſhall not ſail in parallel Lines, but thoſe Lines which they ſhape in their Courſe, ſhall interſect each other, and meet in an Angle.

THEOREM XXIV.

North and ſouth Points have their Terminations, but Eaſt and Weſt have none. Hence the Difficulty in aſcertaining the Longitude at Sea.

THEOREM XXV.

All Places on the Globe are uppermoſt, to their reſpective inhabitants; upwards and downwards in this Caſe, being relative Terms. Hence the Power of Gravity is made manifeſt; for whatever is earthly will incline to the Earth, as its Centre, and be attracted more or leſs, according to the quantity of Matter which it contains.

PART VI.

CONTAINING

Twenty-four PROBLEMS on the CELESTIAL GLOBE, with their SOLUTIONS.

PROBLEM I.

THE Day of the Month being given, to find the Sun's Declination and Right Aſcenſion.

RULE.

Find the Sun's Place in the Ecliptic, for the given Day, and bring it to the Meridian; obſerve what Degree it ſtands under, for that will be his Declination for the given Day; and the Degree of the Equinoctial, which is cut by the Meridian, is his Right Aſcenſion.

Thus, on the 10th of May, his Declination will be 17½ Degrees North, and his Right Aſcenſion 47 Degrees, reckoned from the beginning of Aries.

PROBLEM II.

The Latitude of a Place, Day of the Month, and Hour of the Day being given, to find the Sun's Azimuth.

RULE

RULE.

Rectify the Globe, and fix the Quadrant of Altitude in the Zenith; bring the Sun's Place to the Meridian, put the Index to the upper 12, and turn the Globe till the Index points at the given Hour, and fix it; lay the Quadrant of Altitude over the Sun's Place in the Ecliptic, and the Degrees intercepted between the Quadrant and the neareſt north or ſouth Point will be the Sun's required Azimuth.

Thus, at London, in Latitude 51° 32′ North May 19, at 10 A. M. the Sun's Azimuth will be South, 48 Degrees Eaſt, or S. E. ¼ E.

PROBLEM III.

The Latitude of a Place, and Day of the Month being given, to find the Sun's oblique Aſcenſion and Deſcenſion.

RULE.

Rectify the Globe to the Latitude, and bring the Sun's Place to the eaſtern Side of the Horizon, and mark what Degree of the Equator is cut by the Horizon, for that will be the Sun's oblique Aſcenſion; turn the Globe weſtward, till the Sun's Place lie even with the Horizon alſo, and the Degree of the Equator which is cut by the Horizon, will be the Sun's oblique Deſcenſion.

PROBLEM

2

PROBLEM IV.

The Latitude of a Place and the Day of the Month being given, to find the Sun's aſcenſional Difference, or how much he riſes or ſets before or after Six, without having Regard to the Index.

RULE.

Find the Sun's right and oblique Aſcenſions by Problems I. and III. Subtract the leſſer from the greater and the Remainder will be the aſcenſional Difference; which, reduced into Time, by allowing 15 Degrees to an Hour, and 1 Degree to four Minutes, will give the Time which he riſes before or after Six of the Clock.

Note. The Sun's right Aſcenſion exceeds his oblique Aſcenſion from the Beginning of Aries, to the Beginning of Libra; during which Time he riſes before Six. The Contrary happens from the Beginning of Libra to the Beginning of Aries.

Thus, on the 28th of July, in Latitude 51° 32′ North (the Sun in 5 Degrees of Leo) his right Aſcenſion will be 127½ Degrees, and his oblique Aſcenſion 101½ Degrees; their Difference 26; which reduced, will be equal to 1 Hour and 44 Minutes, and ſubtracted from Six, will leave 4 Hours and 16 Minutes; which is the Hour of the Sun's Riſing on that Day. Or, if added to Six, will ſhew the Hour of his Setting.

PROBLEM V.

The Latitude and the Day of the Month being given, to find the Sun's Amplitude.

RULE.

See Problem XXXVI. on the Terreſtrial Globe; or Problem II. by the Analemma.

PROBLEM VI.

The Latitude, Day of the Month, and Hour of the Night being given, to find the Sun's Depreſſion, below the Horizon.

RULE.

Rectify the Globe for the Latitude; bring the Sun's Place to the Brazen Meridian, putting the Index to Noon; find the Place oppoſite to that of the Sun in the Ecliptic, by turning the Globe, till the Index points to the under 12, or Midnight, and mark it with Chalk or a Pencil; turn the Globe, till the Index points to the given Hour, and ſtay it; lay the Quadrant of Altitude (which muſt be fixed to the Zenith) over the ſaid oppoſite Point in the Ecliptic; then will it ſhew how many Degrees the Sun's Depreſſion is; it being equal to the Height of the oppoſite Point, on the Quadrant of Altitude.

Example. Thus, on the 16th of February, at London, in Latitude 51° 32′ North, at 7 P. M. the Sun's Depreſſion below the Horizon, will be 19° 15′.

PROBLEM VII.

The Latitude, Day of the Month, and Sun's Azimuth being given, to find the Hour of the Day.

RULE.

Rectify the Globe for Uſe, and bring the graduated Edge of the Quadrant to the given Azimuth, holding it there, with the Hand, till the Sun's Place (which muſt be found) touch the ſaid graduated Edge, the Index will give the Hour of the Day.

Example. Thus, on the 10th of September, in Latitude 51° 32′ North, the Sun's Azimuth being S. 40° towards the Eaſt, the Hour of the Day will be found to be 9h. 56m. A. M.

PROBLEM VIII.

Any particular Star being given, to find its Declination and Right Aſcenſion.

RULE.

Bring the given Star to the Meridian, and fix the Globe; obſerve what Degree of the Brazen Meridian is cut, or ſtands directly over the Centre of the given Star, for that is its Declination, North or South, as the Star is north or ſouth of the Equator. Obſerve what Degree of the Equator is cut by the Meridian, for that will be the Star's Right Aſcenſion.

Thus, by the Rule you will find the Declination of Arcturus to be 20½ Degrees, North, and its Right Aſcenſion 210¾ Degrees; the Declination of Capella, in Auriga, to be 45° 30′ North, and its Right Aſcenſion 74½ Degrees; Of Sirius, in the Mouth of the Great Dog, 16¾ Degrees of Declination, South, and Right Aſcenſion 98 Degrees.

PROBLEM IX.

Any particular Star being given, to find its Latitude and Longitude.

RULE.

Elevate the Pole (according as the Latitude is North or South of the Ecliptic) to 66½ Degrees, and bring the Solſticial Colure to the Meridian (or that Point where the 12 Semi-circles meet, which form the Pole of the Ecliptic) and fix the Globe; turn the Quadrant round, till the graduated Edge coincides with the Centre of the Star, and the number of Degrees which the Star is diſtant from the Ecliptic Line will be the Latitude of ſaid Star, and the particular Degree of the Ecliptic which is cut by the Quadrant, is the Star's Longitude, reckoned according to the Signs.

Thus, the Latitude of Arcturus in Bootes, is 30¾ Degrees North, and his Longitude 20½ Degrees in Libra; the Latitude of Capella in Auriga is 22° 40′ North, and Longitude 18½ Degrees in Gemini. The Latitude of Sirius in Canis Major, 39¾ Degrees South, and Longitude 11° 30′ in Taurus

Note. By the two laſt Problems, may the Declination, Right Aſcenſion, Latitude, and Longitude of all the fixed Stars be had. And although their Declination, Right Aſcenſion, and Longitude, be continually changing, by reaſon of the Aberration of the Earth's Axis, round the Pole of the Ecliptic (called the Preceſſion or Receſſion of the Equinoxes) yet in the Time allotted for the Life of Man, there cannot be an Alteration of more than one Degree. See the Receſſion of the Equinoctial Points, Page 59.

PROBLEM X.

The Latitude, and Hour of the Day or Night being given, to repreſent the Face of the Starry Heavens.

RULE.

Rectify the Globe for Uſe, and turn it, till the Index Points to the given Hour of the Day or Night, and fix it; obſerve what Stars are in the upper Hemiſphere, for their Places exactly correſpond with the real ones in the Heavens, (eſpecially if the Globe be placed due North and South). By this it will be an eaſy Taſk to know all the different Conſtellations, and the principal Stars in each; to ſee which are riſing, ſouthing, or ſetting, and by the Quadrant of Altitude (without moving the Globe) to have all their different Altitudes and Azimuths.

Thus, at London, in Latitude 51° 32′, on the 16th of November, at 10 P. M. we ſhall have Caſtor and his Brother Pollux E. N. E. the former 25¼, and the latter 20½ Degrees in Height; Capella, E. by N. ¼N. in Height 54½ Degrees; Procyon, E. ½ N. with 4 Degrees of Altitude. In the E. S. E. Quarter, we have the famous Conſtellation Orion. A little above are the Bull's Eye and Seven Stars. At the Altitude of 60° is the brighteſt in Aries, nearly S. by E. Fomahault is juſt ſetting S. W. by S. Altayr nearly W. at the Height of 9¼ Degrees. Lyra, whoſe Altitude is then 22½ Degrees, on the N. W. by W. Point of the Compaſs, nearly.

PROBLEM. XI.

The Day of the Month and the right Aſcenſion of a Star being given, to find the Time when that Star will culminate, or come to the Meridian.

RULE.

Bring the Sun's Place to the Meridian, and the Index to Noon; then let the Star's right Aſcenſion be brought to the Meridian, and the Index will ſhew the required Hour. Or, ſubtract the Sun's Right Aſcenſcenſion in Time, from the Right Aſcenſion of the Star, and the Southing will be had.

Thus, you will find, that on the 2d of January, the right Aſcenſion of Caſtor being 109½ Degrees, his Southing will be at 0h. 30m. in the Morning; and, on the 13th of February, that the Bull's Eye, whoſe right Aſcenſion is 65° 20′, will culminate at 6h. 38m. P. M.

PROBLEM

PROBLEM XII.

The right Aſcenſion and Declination of any Star being given, to find that Star.

RULE.

Bring the Star's right Aſcenſion to the Meridian, and directly under the given Degree of Declination will be the Star required.

Thus, ſuppoſe it was required to find what Star hath 85 Degrees of right Aſcenſion, and whoſe Declination is 7 Degrees North? By the Rule it will be found to be Bed-elgueze in Orion: a Star of the firſt Magnitude.

PROBLEM XIII.

The Latitude of a Place being given, with any particular Star, to find the oblique Aſcenſion and Deſcenſion of that Star, at that Place.

RULE.

Rectify the Globe for the Latitude, and bring the Star to the eaſtern Side of the Horizon, and fix it. Obſerve what Degree of the Equinoctial is cut by the Horizon, for that will be the Star's oblique Aſcenſion. Turn the Globe till the Star lie even with the Horizon on the Weſt, and that Degree of the Equinoctial which is cut by the Horizon, will be the Star's oblique Deſcenſion.

Thus, at London, in Latitude 51° 32′ North, the oblique Aſcenſion of Caſtor will be 57½ Degrees; and his oblique Deſcenſion 162½ Degrees.

PROBLEM XIV.

To find the Altitude and Azimuth of a Star at any Hour, the Latitude and the Day of the Month being given.

RULE.

Rectify the Globe, and fix the Quadrant of Altitude in the Zenith; bring the Sun's Place to the Meridian, and the Index to the uppermoſt 12; turn it till the Index point to the given Hour, and fix it; lay the Quadrant of Altitude over the Centre of the Star, and its exact Altitude will be ſhewn thereon; and, the Degree which is cut by the graduated Edge of the Quadrant upon the Horizon, reckoned from the North or South, according as it is to the Northward or Southward of the true Eaſt or Weſt Point, will be its required Azimuth.

Thus, you will find, at London, in Latitude 51½ Degrees, on the 22d of December, at 10 P. M. Alderbaran, or Bull's Eye, will have 54¼ Degrees of Altitude, and his Azimuth from the South will be 8 Degrees, Eaſtward. Lyra at the ſame Time will have 6½ Degrees of Altitude, and 29 Degrees of Azimuth; being N. N. W ½ W. nearly.

PROBLEM

PROBLEM XV.

The Latitude of a Place being given, to tell what Stars never ſet, and ſuch as never riſe to the Inhabitants thereof.

RULE.

Rectify the Globe, and ſee what Stars are not further from the Pole than the Number of Degrees equal to the given Latitude, for ſuch can never ſet to that Place; and all Stars in an oppoſite Hemiſphere, whoſe Diſtance from their reſpective Pole exceeds not the Latitude of the given Place, can never riſe to the Inhabitants thereof:—and vice Verſa.

Thus, Lucida Lyra, Capella in Auriga, Algol in Caput Meduſa, the Conſtellation of Urſa Major, Urſa Minor, Cor Caroli, and Draco; Algeneb in Perſeus, Almaac in Andromeda, Scheder in Caſſiopeia, the brighteſt in Cygnus, &c. never ſet to the Inhabitants of the Earth in the Parallel of 51° 32′ North. On the Contrary, the Hull of Argo, Croſero, Pavo, Indus, Grus, Triangle, Phenix, Hydrus, Robur Carol: the brighteſt in Centaurus, &c. never riſe to the Inhabitants of the ſaid Parallel.

PROBLEM XVI.

Two Stars being given, to find the Diſtance between them.

RULE

RULE.

Lay the Quadrant of Altitude over the two given Sars, and the Degrees intercepted between them will will be the Diſtance required.

Thus the Diſtance between Arcturus in Bootes, and Cor Scorpy, the Scorpion's Heart, will be found to be 56 Degrees; and this would be the true Diſtance, were thoſe Stars fixed (as the Ancients believed) in a concave Sphere; but as they are ranged, or rather ſown, through Immenſity of Space, ſome Stars, in Appearance, not more than 5 Degrees apart, may be diſtant many Millions of Millions of Miles.

PROBLEM XVII.

To find the Riſing, Southing, and Setting, of all the Planets; the Latitude of a Place and the Day of the Month being given.

RULE.

Rectify the Globe for Uſe, and find by White's Ephemeris the Places of the Planets, with their Latitudes, for the given Day; on the Places of *each*, ſtick a Patch or Character of the Planet; then, by the Revolution of the Globe, you will ſee the Hours of riſing, ſouthing, and ſetting of thoſe rolling Orbs: by which Means you will be enabled to diſtinguiſh them from the fixed Stars, and to name at firſt Sight the Conſtellations and particular Stars in the Neighbourhood of each; which muſt not only prove inſtructive, but entertaining to the judicious Obſerver.

Thus, on the 14th of November 1787, at London, in Latitude 51° 32′ North, the Sun and all the Planets will riſe, ſouth, and ſet, as follows:

	Riſing.	Southing.	Setting.
	H. M.	H. M.	H. M.
Sun, .	7 37	————	4 23
Moon,	11 38 A. M.	3 50 P. M.	7 50 P. M.
Mars,	8 30 P. M.	4 44 A. M.	1 0 P. M.
Mercury	9 45 A. M.	1 32 P. M.	5 13 P. M.
Jupiter,	6 10 P. M.	2 28 A. M.	10 30 A. M.
Venus,	8 15 A. M.	0 30 P. M.	*4 47 P. M.
Saturn,	1 54 P. M.	6 30 P. M.	11 5 P. M.

Note. Stars that riſe or ſet at the Time of Sun-riſing, riſe and ſet *coſmically.* Stars that riſe or ſet when the Sun ſets, riſe and ſet *acronically.* Stars that are ſeen in the Eaſtern Horizon, a little before Sun-riſe, riſe *heliacally:* and thoſe that are ſeen in the Weſtern Horizon a little after Sun-ſetting, ſet *heliacally;* called the *poetical* Riſing and Setting, becauſe mentioned frequently by the ancient Poets.

PROBLEM XVIII.

The Latitude of a Place, the Day of the Month, and the Altitude of any particular Star being given, to find the Hour of the Night, and the Star's Azimuth.

RULE.

See the 25th Problem on the Terreſtrial Globe, for the Hour of the Day by having the Sun's Altitude.

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* Heliacally.

Note. The following Six Problems are uſeful in Navigation.

PROBLEM XIX.

The Sun's Declination and Amplitude being given, to find the Latitude.

RULE.

Elevate the North Pole (if in North Latitude) to the Complement of the true Amplitude, and bring the firſt Degree of Aries to the Meridian; fix the Globe, and ſcrew the Quadrant of Altitude to the Zenith; mark the Degrees of the Sun's Declination upon the Quadrant, and move it till the ſaid Mark cut the Equator, which it will do in the Latitude required.

Thus, when the Sun's Declination is 15 Degrees North, and his Amplitude from the Eaſt Northerly 20 Degrees, the Latitude will be equal to 43 Degrees North.

PROBLEM XX.

The Sun's meridian Altitude and Declination being given, to find the Latitude.

RULE.

Mark the Sun's Declination on the Meridian, and move the Globe upwards or downwards till the given Altitude be meaſured between that Mark and the Horizon; then will the Elevation of the Pole be equal to the Latitude.

Thus, when the Sun's Declination is 15 Degrees North, and his meridian Altitude is 55° 20′, the Latitude of the Place of Obſervation, is 49° 40′ North.

PROBLEM XXI.

Two Stars being given, the one upon the Meridian, and the other in the Eaſt or Weſt Part of the Horizon, to find the Latitude of the Place.

RULE.

Bring the Star which is obſerved on the Meridian to the Meridian of the Globe, and move the Globe up or down, in the Notches, till the other Star make its Appearance, on the Eaſt or Weſt Part of the Horizon; the Pole will then be elevated to the Latitude required.

Thus, ſailing in the Ocean, I obſerved Arcturus on the Meridian, and Cor Scorpy juſt riſing; and being deſirous of knowing the Latitude of the Ship, I found that it anſwered, by the above Rule, to be 60° 25′, North.

Alſo, in another Voyage, I obſerved Procyon on the Meridian, and the Virgin's Spike riſing; and found, that the Ship's Latitude, at that Time, was 25 Degrees, North.

PROBLEM XXII.

The meridian Altitude of any particular known Star being given, to find the Latitude.

RULE.

Bring the obſerved Star to the Meridian of the Globe, from which, reckon the given Altitude towards the South, upon the Brazen Meridian, and where the Reckoning ends, make a Mark; move the Globe in the Notches, till that Mark be even with the Horizon, and the Latitude will be equal to the Pole's Elevation.

Thus, when the meridian Altitude of Cor Leonis, is obſerved to be 63½ Degrees, the Latitude of the Place will be 40 Degrees, North. And when the meridian Altitude of Capella is obſerved to be 75½ Degrees, the Latitude of the Place of Obſervation, is 60 Degrees, North; and ſo, for any other Height.

PROBLEM XXIII.

The Altitude and Azimuth of any particular Star being given, to find the Latitude.

RULE.

Raiſe the Pole to the Altitude of the given Star; fix the Quadrant of Altitude in the Zenith, and lay it to the Star's given Azimuth; then move the Globe backwards or forwards, till the given Star meets the ſame, which it will do in the required Latitude.

Thus, when the Altitude of Arcturus in Bootes, is 40 Degrees, and he is obſerved to bear upon the E. S. E. Point of the Compaſs, the Latitude will be found to be 54° 45′ North.

PROBLEM

PROBLEM XXIV.

The Day of the Month, and Hour of the Night, that a Star is either riſing or ſetting, being given, to find the Latitude.

RULE.

Repreſent the Face of the Heavens for the given Time, and move the Globe backwards or forwards, till the obſerved Star lies in the eaſtern or weſtern Horizon accordingly, and the Latitude will be equal to the Height of the Pole.

On the 20th of January, at 10h. P. M. I obſerved that Arcturus was juſt riſing, and by the above Rule, found, that the Latitude of the Place of Obſervation was 51° 32′ North.

A TABLE

BRITISH MUSEUM

A TABLE of the Magnitudes, Right Aſcenſions, and Declinations, North or South, of thirty principal FIXED STARS, for the Uſe of the LEARNER, taken from Meſſrs. PALMER and NEWTON's 15 Inch Globe, whereon their Places are rectified to the Beginning of 1785.

Names of the Stars and Conſtellations.	M.	R. A.	Declin.
Aldebaran, or Bull's Eye	1	65° 20′	16° 00′N.
Algol, in Meduſa's Head	2	42 : 50	39 : 40
Altayr, in Aquilla	1	294 : 30	8 : 10
Andromeda's Head	2	358 : 30	27 : 30
Andromeda's Foot	2	27 : 00	41 : 00
Arcturus in Bootes	1	210 : 45	20 : 30
Bellatrix in Orion	2	77 : 30	6 : 10
Bedelgeuze in ditto	1	84 : 50	7 : 00
Canobus in Argo Navis	1	94 : 10	53 : 00 S.
Capella, in Auriga	1	74 : 30	45 : 30 N.
Caſtor, in Gemini	1	109 : 30	32 : 10
Cor Scorpionis	1	242 : 45	26 : 10 S.
Cor Hydræ	2	138 : 15	8 : 30
Cor Leonis in Leo major	1	148 : 40	13 : 15 N.
Deneb, in ditto	1	174 : 20	16 : 10
Draco's Head	2	268 : 30	52 : 00
Fomahault	1	340 : 30	31 : 10 S.
Markeb, in Pegaſus	2	342 : 45	13 : 40 N.
Menkar, in Cetus	2	42 : 00	2 . 30
Procyon, in Canicula	1	111 : 10	5 : 30
Pes Centauri	1	215 : 00	60 : 00 S.
Pleiades, or Seven Stars	4	52 : 30	23 : 15 N.
Rigel, Orion's left Foot	1	75 : 30	8 : 45 S.
Sirius, in Canis major	1	98 : 00	16 : 45
Spica, in Virgo	1	197 : 30	10 : 00
Star in the ſouth. Scale	1	219 : 00	15 : 00
1ſt. Star in Orion's Belt	2	79 : 30	1 : 00
2d. ditto in ditto	2	80 : 30	1 : 30
3d. ditto in ditto	2	82 : 00	2 : 30
Vindemiatrix in Virgo	3	192 : 30	12 : 15 N.

AN
APPENDIX,

Being a curſory View of the SOLAR SYSTEM, *introduced in a* Dialogue *between the* MASTER *and* SCHOLAR.

SCHOLAR.

SIR, by your Care and Inſtruction, I have been enabled to *reſolve* a variety of curious and intereſting Problems on the Globes, and to traverſe the Earth, as well as the beautiful celeſtial Fields, from Pole to Pole; in the Performance of which, I muſt acknowledge to have received much Satisfaction; at the ſame Time, to have acquired ſome ſlight Acquaintance with Aſtronomy; and, Sir, as you have often ſaid, that it is a Science the moſt noble, and withal, ſo eaſy in the attainment, I long to be further acquainted with it; your Aſſiſtance, by explaining the Copernican Syſtem, (or, as it is called, the *Newtonian* Syſtem) will confer additional Obligations.

Maſter. I am exceeding glad, my dear Pupil, that your Genius has anſwered my Hopes, and that my Labour has not been beſtowed in vain; it is no ſmall Degree of Satisfaction which I have, in hearing your Name mentioned among the learned; and believe me, nothing can pleaſe me more, than your Propoſal of Queſtions, that tend to Edification; It is with the greateſt Pleaſure imaginable, that I embrace the Opportunity of accompanying you in a View of the Solar Syſtem, and I make no doubt of your becoming as great a Proficient in the *Aſtronomical Line*, as you are allowed to be in the *Geographical One*.

Scholar. Sir, your Compliments on my Abilities do me honour.

Maſter. They are not more than you deſerve. But that we may loſe no Time, and the Planetarium is here before us, let us begin our Survey at the *Sun*, the large gilded Ball, which you here obſerve in the Centre of the Inſtrument.

OF THE SUN.

This huge Body, which can be nothing elſe than a ſolid Globe of Fire, diſpenſing *Light* and *Heat* through the Univerſe; and, huge as this Body is, (being upwards of 1,200,000 Times bigger than the Earth) he revolves round his Axis in 25¼ Days, making an Angle with the Plane of the Ecliptic of 82 Degrees; which Motion and Inclination are known, by obſerving certain black Spots paſſing over his Diſk, and returning to the ſame Place, in the above mentioned Time.

In this Globe is contained and treaſured up, that attracting Energy, or Gravitation, by which the planetary Worlds are retained in their Orbits; acting in proportion to the Diſtance, and quantity of Matter in each, and is a grand Diſplay of divine Goodneſs.

Strange have been the Conjectures of Men, reſpecting the Sun: Some ſuppoſing it to be the Place of Torment, appointed by the Omnipotent, for the damn'd and diſobedient Spirits; whilſt, on the other Hand, it has been imagined to be a grand Lamp, at the golden Portals of the celeſtial City.

OF MERCURY.

We are next preſented with the nimble Planet Mercury (ſtiled by Poets, the Meſſenger of Jove) his greateſt Elongation being not more than 27 or 28 Degrees; conſequently, ſo ſtrongly illuminated by the Sun, that all attempts to diſcover his diurnal Rotation, have hitherto proved unſucceſsful.

The periodical Revolution of Mercury, from Weſt to Eaſt, (which is his Year) is performed in 87 Days, 23 Hours, and 13 Minutes; his Diameter is 3000 Miles, and his Orbit inclines to the Ecliptic in an Angle of 7 Degrees, nearly.

The aſcending Node of Mercury, is in 15¾ Degrees of Taurus, (the Deſcending being oppoſite) and his Aphelion Point, or greateſt Diſtance from the Sun (for none of the Planets move in perfect Circles) is in 13¾ Degrees of Sagittarius, or the Archer; which Diſtance is known to be upwards of 36 Millions of Miles, and he moves in his Orbit at the amazing Rate of 109699 Miles in one Hour. The Light and

Heat of this Planet compared with the Earth is as 7 to 1.

OF VENUS.

We now come to the brilliant and lucid Planet Venus, moving likewiſe in an Orbit, within that of the Earth; her greateſt apparent Elongation, being near 47 Degrees, and hence ſhe becomes our refulgent Evening and Morning Star alternately.

The Diameter of Venus is 9360 Miles; ſhe moves in her Orbit, from Weſt to Eaſt, at the Diſtance of 68 Millions of Miles from the Sun, and at the Rate of 80000 Miles in one Hour, compleating her Revolution in 224 Days 17 Hours; turning round her Axis in 24 Days 8 Hours. Her aſcending Node is in 14° 30′ of Gemini, making an Angle with the Plane of the Ecliptic of 3° 20′; her Aphelion Point is in 7° 36′ of Aquarius. The *Light* and *Heat* of Venus compared with the Earth, is as 2 to 1.

The frequent Tranſits of this Planet over the Sun's Diſk, have been of the greateſt Uſe to Aſtronomers; and it is greatly to the Honour of Britain, that the firſt from the Creation, upon Record, was diſcovered by our own Countryman, Mr. Horrox of Lancaſhire, in the Year 1639.

N. B. Mercury and Venus are called inferior Planets, their Orbits being circumſcribed by the Earth's.

OF THE EARTH AND MOON.

In the next Place, we are favoured with a View of our own Globe, a denſe opaque Body, (as all the Planets are) moving in an Orbit 95 Millions of Miles from the Sun, at the Rate of 68,243 Miles in an Hour; finiſhing her Courſe round the Sun in 365 Days, 5 Hours 49 Minutes, and round her Axis in 24 Hours.

The Axis of the Earth inclines to the Plane of her Orbit (called the Ecliptic) in an Angle of 23½ Degrees nearly; hence the Sun's Declination; and by always retaining the ſame Paralleliſm, the agreeable changes of Spring, Summer, Autumn and Winter are produced, ſo neceſſary for the Benefit of the ſeveral Inhabitants.

The Diameter of the Earth is 7970 Miles, and her Aphelion Point is in 9 Degrees of Capricorn.

OF THE MOON.

The Moon is an Attendant of the Earth, (ſhining by the borrowed Beams of the Sun) and reſpecting her as the Centre of Motion; the Diſtance of the Moon from the Earth's Centre is 240000 Miles nearly; her Diameter 2170 Miles; ſhe is known to turn round her Axis in the preciſe Time that ſhe takes to go round from any Point of her Orbit to the ſame again, which is 27 Days 7 Hours 43 Minutes (keeping the ſame Side towards the Earth) and is called her periodical Revolution.

The exact Time from Change to Change is 29 Days 12 Hours 44 Minutes 3 Seconds, called her Synodical Revolution, and is the Length of her Day and Night if taken together; for if ſhe was obſerved from the Sun, ſhe would only turn round her Axis in that Time.

The Difference of theſe Revolutions is cauſed by the Earth's annual and progreſſive Motion round the Sun, otherwiſe ſhe would always change upon the ſame Part of her Orbit.

It is well known to Aſtronomers, and even proved experimentally by the Planetarium, as you ſhall ſee, that a luminous Body can only enlighten one half of an opaque Globe at once; hence the different Phaſes of the Moon as ſeen from the Earth, and which is alſo manifeſt in the Planets Venus and Mercury.

When the Moon is between the Earth and the Sun, ſhe diſappears; becauſe her unenlightened Side is toward the Earth. When ſhe is oppoſite to the Sun, we ſay ſhe is full, becauſe her enlightened Side is then towards the Earth. When 90 Degrees, or a Quarter of a Circle diſtant from the Sun, ſhe appears half full, becauſe half of her enlightened Side is then ſeen by us.

The Earth puts on every different Appearance in common with the Moon, to the Lunarians, with this Difference, that ſhe reflects 13 Times more Light, her Surface being 13 Times larger.

The hourly Motion of the Moon, in her Orbit, in reſpect to the Earth, is about 2290 Miles.

The Orbit of the Moon inclines to the Ecliptic, in an Angle of 5 Degrees 18 Minutes; and hence it is that, we have not an Eclipſe of the Sun at every Change, or of the Moon every Time that ſhe comes in Oppoſition; and in this Contrivance alone, the *Wiſdom* and *Preſcience* of the Almighty paſſeth all human Underſtanding, and confirms what the immortal YOUNG (ſo much like himſelf) ſays, That

> "An undevout Aſtronomer is mad."

More of this hereafter, let us therefore paſs to the Planet Mars.

OF MARS.

This ruddy-coloured Planet moves in an Orbit above the Earth and Moon, at the Diſtance of 145,014,148 Miles from the Sun; his Diameter is 5400 Miles; and goes round the Sun from Weſt to Eaſt in 1 Year 321 Days 17 Hours, at the Rate of 55,287 Miles in one Hour; and turns upon his Axis in 24 Hours 40 Minutes.

Mars enjoys but half as much Light and Heat as the Earth; and it is not known to Aſtronomers, whether he is bleſſed with a ſecondary or not; however, this we may venture to ſay, if he have not a Moon to attend upon him, that he ſtands in Need of no ſuch Aſſiſtant; for HE who ſpoke, thoſe numerous planetary Worlds from nothing, deals not with a partial Hand. The Inclination of the Orbit of Mars to the Plane of the Ecliptic is near 2 Degrees; the Place of his aſcending Node is in 18 Degrees of Taurus; his Aphelion Point is in 2 Degrees of Virgo.

When

(Macdy)

When Mars is in Oppoſition to the Sun, he is 5 Times nearer the Earth than at his Conjunction.

To the Inhabitants of Mars, the Earth and Moon will put on every Appearance which the Planets Venus and Mercury do to us; except, that every Month they will be ſeen to change Place with each other, and become their Evening and Morning Stars alternately.

This Planet's appearing more *red* and *firy* than others, has been attributed by ſome, to the *Nature* of the *Soil*; by others to the Thickneſs of his *Atmoſphere*; the latter, however, ſeems moſt probable; for the Sun or Moon, when ſeen through our own hazy Atmoſphere, will always appear with the ſame troubled Aſpect.

OF JUPITER AND HIS MOONS.

This noble Planet is placed in the Syſtem, at the Diſtance of 495 Millions of Miles from the Sun, his Diameter is 94 thouſand Miles, conſequently near 1200 Times larger than the Earth; his hourly Motion in his Orbit is 29,083 Miles, and turns round his Axis (large as he is) in 9 Hours 56 Minutes.

His Year, (which is the Time that he takes to turn round the Sun) is performed in 11 Years 314 Days 18 Hours.

The *Inclination* of the Orbit of this Planet to the Ecliptic is 1° 20′; his aſcending Node is in 8½ Degrees of Cancer, and his Aphelion Point in 11 Degrees of Libra.

On the Surface of Jupiter, are certain Streaks called his Belts, and a Spot, by which his Rotation was diſcovered; theſe, however, are ſuppoſed to be in his Atmoſphere, as they frequently change Appearances.

The *Light* and *Heat* of Jupiter is but one 27th Part of what the Earth enjoys. But then he is amply rewarded by four faithful Attendants, which move round him in the following Manner.

The firſt, or neareſt, in 1 Day 18 Hours 36 Minutes; the ſecond, in 3 Days 13 Hours 15 Minutes; the third, in 7 Days 3 Hours 59 Minutes; and the fourth, in 16 Days 18 Hours 30 Minutes.

By the Eclipſes of theſe Satellites it is found that Light is conveyed to us from the Sun in 8 Minutes of Time, which is nearly 12 Millions of Miles in 1 Minute, and nearly 12 thouſand Times as faſt as the Earth moves in her Annual Orbit: A Swiftneſs inconceivably rapid!

The frequent Eclipſes of theſe Moons are of the greateſt Uſe to our Navigators, in diſcovering the Longitude at Sea, &c. for which we ſtand indebted to the famous Italian Aſtronomer, GALILEO, by whom theſe Moons were diſcovered, in January 1610.

OF SATURN AND HIS FIVE MOONS.

This Planet, which is the laſt upon the Inſtrument, moves in an Orbit near 908 Millions of Miles from the central Sun, at the Rate of 22,102 Miles in an Hour; finiſhing his Circuit in 29 Years 167 Days.

The Diameter of Saturn is 78000 Miles, excluſive of a lucid Ring, which circumſcribes his Body at the Diſtance of 21000 Miles therefrom, and nearly of that Breadth; which Ring is a curious Phænomenon, and has afforded much Speculation to Aſtronomers. This remote Planet is known to have five Moons, moving round him in the following Order, viz. The neareſt in 1 Day 21 Hours 19 Minutes; the ſecond in 2 Days 17 Hours 40 Minutes; the third in 4 Days 12 Hours 25 Minutes; the fourth in 15 Days 22 Hours 41 Minutes; and the fifth in 79 Day 7 Hours 48 Minutes.

The *Light* and *Heat* of the Sun at Saturn is ninety Times leſs than what the Earth enjoys. His aſcending Node is in 21° 26′ of Cancer, making an Angle with the Ecliptic of 2½ Degrees. His Aphelion is in the Beginning of Capricorn.

Note. Mars, Jupiter, and Saturn are called ſuperior Planets, their Orbits being higher than the Earth's.

GEORGIUM SIDUS.

This Planet (which is not yet put upon the beſt Inſtruments) has been lately diſcovered by the celebrated Hanoverian Aſtronomer, Dr. Herſchell; moving in an Orbit much more remote than the Planet Saturn, and ſuppoſed, by its Diſtance from the Place where firſt obſerved, to perform its Courſe round the Sun, in 90 Years, or thereabouts. Dr. Herſchell obſerves, that this Planet's Orbit differs conſiderably from any other of the Planets, making a much larger Angle with the Ecliptic, and not confined to the Zodiac, as the other Planets are; but Time and the future Obſervations of this able Aſtronomer, will, no doubt, ſatisfy the World, reſpecting this wide wandering Globe.

OF COMETS.

Beſides the ſeveral Planets before-mentioned, there are a kind of Erratics, called Comets, moving in very long Elipſes, appearing ſuddenly, and after a ſhort Continuance, ſuddenly diſappear. Notwithſtanding the great Number of Comets which have appeared, only *three* have had their Periods determined. The Comet which appeared in 1680, will return after a Period of 575 Years. That which appeared in 1661 will viſit us again in 1789, its Period being 128 Years; and the Comet of 1759, will return in 1835, its Period being 76 Years. There have been various Opinions, reſpecting Comets, the moſt probable is, that they are denſe compact Bodies, ſhining by the ſolar Light. They are known to deſcribe equal Areas in equal Times (as all the Planets do) moving much faſter in their Perihelion than when in their Aphelion; hence their ſudden Diſappearance, and long Continuance in the remote Regions of the Univerſe.

And now, my *dear Pupil*, I have given you the Heads of the grand Orrery of the Univerſe (which this Inſtrument is intended to repreſent) and when Opportunity again ſerves, you ſhall be made acquainted with the Manner of calculating their ſeveral Diſtances, *Relative* and *Abſolute*, together with the Theory of the *Moon*, *Winds*, *Tides*, &c. But, before I conclude, muſt beg, that whilſt you reflect on what has already been delivered, that you be careful to aſcribe all Honour, Praiſe, and Glory, to that BEING, who *governs* and *directs* this vaſt *Machine*, in all its various Turnings, and who is none other, than

"*Nature*'s CONTROULER, AUTHOR, GUIDE, and END."

Scholar. Sir, I heartily thank you, for this Indulgence; and, believe me, nothing ſhall draw me aſide from this grand Purſuit, the *Search after Knowledge*.

Maſter. Farewel.

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Vickers Robert, *Swinfleet.*

W.

Wainwright John *Shef.*
Walker Joſeph, *Shef.*

Walker William, *Shef.*
Walton ——— *ditto.*
Wardle ——— *ditto.*
Warris ——— *ditto.*
Warris Thomas, *ditto.*
Watkinſon ——— *ditto.*
Wells John, *ditto.*
Wheat James, *ditto.*
Whitfield ——— *Sedgefield.*
Wilde Charles, *Shef.*
Wilde George, *ditto.*
Wilſon Thomas, *London.*
Wilſon Joſeph, *Shef.*
Willis ——— *ditto.*
Wilſon ——— *ditto.*
Wilſon, Rev. Mr. *Kennington.*
Wolfe, Rev. Mr. *Howick.*
Woollen Robert, *Shef.*
Wright John, *Nether Broughton.*
Windſor William, *London.*
Windſor David, *ditto.*
Windſor William, *ditto.*

Y.

Yates ——— *Shef.*

[illegible]

FINIS

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